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ABSTRACT

Variables that affect the deductive reasoning of adult students are isolated and relevant literature reviewed in order to facilitate the design of a reliable measurement instrument. The relationships of previous instruction, cultural background, occupation, intelligence, sex, and reasoning habits to test scores of examinees are discussed. Studies of the effect on examinees of argument format, use of logical connectives, language inconsistencies, item difficulty levels, abstractness, and argumentative content are reviewed. Implications of this literature review are that future deductive reasoning ability measurement devices should a) include provisions for assessing decisions involving both valid and invalid principles of reasoning; b) measure decisions for each structural type of logical argument; c) utilize premises which are properly qualified, consistent with generally accepted facts, and constructed of neutral components; d) utilize standardized logical connectives; and e) measure the emotional effect of arguments on respondees. An 11 page bibliography is included. (HMD)

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FACTORS THAT MAY AFFECT DEDUCTIVE REASONING IN ADULT STUDENTS ENROLLED IN EDUCATIONAL RESEARCH CLASSES: A REVIEW OF EMPIRICAL- AND EXPOSITORY-DOCUMENTS FROM NON-TEXTBOOK LITERATURE BETWEEN 1920 AND 1973

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I. INTRODUCTION

It seems fitting to modify the following problem pursued in 1935 by Woodworth and Sells:

> Why some syllogisms make easy problems and others difficult ones is a question for psychological inquiry.[1]

The modifications proposed would be substitution of "arguments" for "syllogisms" and deletion of "psychological." The present review is intended to reflect an inquiry that has been so directed. This review summarizes ideas gathered from related studies defining the present status of logic and from studies relevant to logical performance that amplify the influences of argumentative content, subject's background characteristics, and the relation of his critical emotional reaction to conclusions he draws. Experimental studies associated with reasoning, descriptive studies associated with factors affecting reasoning, and expository documents concerned with the theoretical, often untested, aspects of logic constitute the domain of literature reviewed. Within this domain particular emphasis has been placed on variables associated with prior instruction, with cultural background, and with occupational role. Other independent characteristics examined are intelligence of subjects, sex, their reasoning habits, and age. In addition argumentative

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[1]Robert S. Woodworth and Saul B. Sells, "An Atmosphere Effect in Formal Syllogistic Reasoning," Journal of Experimental Psychology 18 (August 1955): 451.

content is reviewed in terms of influences of logical connectives, atmosphere effect, item difficulties, presentation format, and abstractness. Important considerations associated with subject's reaction to conclusions consistent with background premises are analyzed. Finally, some implications of the review for educational research are considered.

A PERSPECTIVE FOR THE REVIEW

It could be argued that some of what passes for educational research is actually conceptual analyses for which philosopher logicians may be better suited by training and discipline than educators. Reed, in viewing this problem, contends that nonphilosophical disciplines, such as education, could profit by implementing analytical philosophy to clarify techniques of expository analysis.[1] Karplus and Karplus, also focus on the problem, suggesting that their Islands Puzzle Study on subjects ranging from fifth grades through college physics teachers

> . . . calls attention to a neglected area of educational research which has significant bearing on large scale improvements in scientific literacy. It is furthermore likely that [logical] tasks can be constructed to assess . . . other components of formal thought.[2]

Pratt observed, in 1928, that "the essential character of reasoning, on its formal side, may be regarded as the insight into the relation between premise and conclusion." "The awareness of this relation is an immediate bit of knowledge that cannot be reduced to any

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[1]T. M. Reed, "Analytic Philosophy in the 20th Century," American Libraries 2 (December 1971): 1161-1168.

[2]Elizabeth F. Karplus and Robert Karplus, "Intellectual Development Beyond Elementary School, I: Deductive Logic," School Science and Mathematics 52 (May 1970): 404.

category of sense experience."[1] Little was found in the literature after 1928 to amplify or extend that observation. The investigative drought on this theme was critically reiterated by Morgan and Morgan in 1953 in terms of the psychological literature. They stated:

> It is very strange indeed that psychologists have paid so little attention to problems of logical reasoning. During the last 50 years no systematic and comprehensive approach has been undertaken by them toward these problems. We made a careful search of the literature since 1921 and found 21 references to experimental studies of logical reasoning, and we were rather generous in our interpretation of what constitutes an experimental study. . . . It is difficult to understand why supposedly hardbitten, scientifically-minded psychologists have given so little attention to this problem. . . . Psychologists seem [also] to be under the delusion that logical reasoning is confined to the syllogism, a view which has long been abandoned by the logicians themselves.[2]

On the other hand, normative statements about the desirability of sound reasoning abound in textbooks concerned with educational research although those same references may be criticized for devoting minimal space to discussions of logical criteria for assessing arguments or drawing conclusions.[3]

Besides those limitations reflected in the title of this review, the reader should also note that this investigation has also been arbitrarily limited to those reports primarily concerned with products of reasoning rather than with the intellectual operations associated with

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[1]Carrol C. Pratt, "Experimental Studies of Thought and Reasoning," Psychological Bulletin 25 (September 1928).

[2]William J. Morgan and Antonia Bell Morgan, "Logical Reasoning: With and Without Training," The Journal of Applied Psychology 37 (October 1953): 399.

[3]The first chapter of the writer's Ph.D. dissertation, "An Evaluation of Deductive Reasoning Outcomes With Educational Arguments," considers this problem in some detail. (This is a forthcoming work that may become available from University Microfilms.)

reasoning processes. Thereby, a distinction between performance and the psychological processes underlying performance prevails. Moreover, the points of view will be held that (1) awareness of the formal rigorous techniques from logic may influence the degree of commitment one holds for any argument and (2) whatever accurate approach, psychological or otherwise, one uses for analyzing an argument can be ultimately reduced to a basis from formal logic. The latter view is intended to suggest that, in terms of a product, methods of analysis can be analogically dependent on modern theories of logic. This generalization is adhered to whether the premises for the argument are true factual propositions, false factual propositions, or true logical (concluding) propositions. If one wishes to question the truth of a premise, he merely attacks the argument supporting that premise as its conclusion, continuing backward through one background argument after another until all the evidence supporting the questioned premise has been systematically examined. Such an exercise, however, may not resolve distortions that may occur in the translations of ordinary arguments into the language of formal logic. In the absence of distortions such that effective communication ensues, a common logic should hold.

Language is considered as the essential tool functioning to communicate thought. Indeed, language clearly serves, in logic tests or other argumentative communications, for expression of ideas with interconnected words arranged in sentences that are logically interrelated, connected, or sequenced with each other to convey the larger components of thought. To be logically sequenced suggests that ideas flow according to principles of order and organization such that transitions or

abstractions from foundational statements to concluding propositions are unambiguous and noncontradictory. Conclusions output are thereby consistent with ideas encoded as their input evidence. Transitions, or abstractions, occur through mechanisms that are not understood but for present purposes may be labeled as "intuition" though in other places they have been referred to as "psychological processes." Logic and intuition appear to somehow interact in thought and its communication, logic serving to demonstrate validity for a chain of ideas and intuition for inventing and/or creating those ideas. Intuition seems to spawn the notions that logic can promote to a status of relative certainty.

Lefford commented on the relation of intuitive transition to logical inference. In his opinion:

> A logical inference may be valid or invalid in accordance with the rules of logic, but a psychological inference is not valid or invalid except when judged as a logical inference: psychological inference is purely a fact.[1]

THE EDUCATOR AND LOGIC

However intuition may affect his decisions, one probably employs logic, accurately or inaccurately, for solving many of his problems. For this role it may be well to note one of Melzer's concepts for the function of logic:

> Perhaps the major part of the actual solving of problems takes place in the realm of professional and amateur research. Here the researchers develop tentative hypotheses deductively from factual knowledge at hand and then carefully attempt to arrive at inductive verifications ruling out as many as possible of the

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[1]Arthur Lefford, "The Influence of Emotional Subject Matter on Logical Reasoning," The Journal of General Psychology 34 (April 1946): 145.

> variables. Then, on the basis of the verifications, the hypothesis is either modified, thrown out or considered partially established. Then the conditions under which such a procedure is carried out are reexamined and repeated by others.[1]

Should there be adequate, but incomplete, evidence to support the truth or falsity of one's solution for his problem then laws of probability and statistical significance may be called upon to qualify that solution.

Have students, in their normal courses of instruction or as a consequence of other factors, learned to discriminate between valid and invalid arguments and to provide conclusions for incomplete arguments? This question arises from reviewing Miller's study[2] and continues to need an answer. Miller may himself have some discrimination problem since he claims Guilford's "Structure of the Intellect" to be " . . . probably the most extensive study involving logical reasoning . . . ."[3] In this claim, Miller seems to be confusing two worlds of discourse: (1) the theoretical, factor-analytical characterization of intelligence advanced by Guilford and (2) the results of applying rules for logical consistency to statements composing arguments.

Smith studied didactic discourse taped in seventeen selected classrooms in five selected schools from five selected communities. Five consecutive classes were taped from each classroom. From these eighty-five teaching sessions Smith found that the units of classroom

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[1]John Henry Melzer, "What is Functional Logic?" Peabody Journal of Education 30 (July 1952): 85.

[2]William Anton Miller, "The Acceptance and Recognition of Six Logical Inference Patterns by Secondary Students" (dissertation, University of Wisconsin, June, 1968; Ann Arbor, Michigan: University Microfilms, 1968, No. 68-13,651).

[3]Ibid., 25.

discourse ("monologues" and "episodes") could be indexed by the logic called forth in their idealized responses into twelve logical categories and one non-logical "directing and managing classroom" category. The twelve logical categories each have a logical dimension through involving questions either of truth value, of validity and invalidity, or of consistency. These categories are (1) "defining," (2) "describing," (3) "designating," (4) "stating," (5) "reporting," (6) "substituting," (7) "valuating," (8) "opining," (9) "classifying," (10) "comparing and contrasting," (11) "conditional inferring," and (12) "explaining." On the basis of his data Smith was able to conclude

> . . . that the number of [logical] entries varies significantly from one category to another. Describing, Designating . . . , and Explaining . . . are the three most frequently occurring operations in that order . . . . The least prevalent operations . . . seem to be Substituting, Reporting, and Classifying.[1]

The "explaining" category of teaching appears to have greatest relevance to the sense in which logic functions in research. Smith considered explanation to require the explainer to provide antecedent propositions given a consequent. This should be contrasted with "conditional inferring" which requires the inferer to provide a consequent having been given relevant antecedent propositions. In all twelve categories permissiveness of instruction was considered to be a reflection of the extent to which responding instructional transactions for the specific

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[1]B. Othanel Smith, "A Study of the Logic of Teaching. A Report on the First Phase of a Five Year Research Project: The Logical Structure of Teaching and the Development of Critical Thinking," an ERIC typescript having Accession Number ED015164 (Urbana, Illinois: College of Education, Bureau of Educational Research, University of Illinois. n.d. [filmed on June 4, 1968]), pp. 7.2-7.5. [There are two pages of intervening tables.]

"episodes" do not match the logic called forth by their respective "entries." (An episode involves more than one person. An entry is the opening of an episode.)

Harris argues for the expansion of teacher education programs into logic. He supports this point as follows:

> The teacher relies upon . . . basic logical principles in the art of teaching no less than the child does in learning. The activities of explaining, analyzing, and describing all presuppose the abilities of recognizing the proper relationships between statements and identifying and using valid forms of deductive argument. If it is undesirable to leave such matters to chance with students, a fortiori so it is with teachers. Formal instruction in logic should be included in every teacher's formal education.[1]

On the basis of four experimental studies of reading comprehension, Robertson recommended that teachers should match logical connectives of classroom reading materials to the logical connectives with which students have familiarity and use in speaking. She also suggested that logical connectives should have instructional emphasis in order to develop abstract logical thinking abilities of students.[2]

The foregoing are but a sampling of applications of logic to the educational process. They illustrate the need for logical decision making in the research component of education, the problem solving component and the instructional component. In each case it should be

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[1]James F. Harris, Jr., "On the Primacy of Logic," Educational Forum 35 (May 1971): 524.

[2]Jean E. Robertson, "Reading Comprehension: A Linguistic Point of View," a paper presented at the annual meeting of the American Educational Research Association, Minneapolis, Minnesota, March 2-6, 1970; an ERIC typescript having Accession Number ED038632.

kept in mind that logic is viewed as a science of decision about the quality of arguments and is not to be confused with the processes whereby decisions are made.

A STATEMENT OF FOCUS

The remainder of this review will analyze those variable conditions that are believed to affect the probability of an educator's correct assessment of educational arguments and correct selection of logically consistent conclusions for sets of premises whose argumentative content is of an educational nature. In fact, this review is particularly directed to the isolation of variables pertinent to constructing instruments for measuring deductive reasoning in adult students. This is done in the belief that an awareness of the published history of specific variables and their interactions will assist an instrument architect in writing questions of highest probable relevancy and reliability, and of smallest unexplained- or error-variance.

II. FACTORS AFFECTING REASONING

CLASSIFICATION FACTORS

Several groups of variables are considered as component subtopics for this chapter. In essence they are those variables characteristic of the individuals with whom a reasoning investigation may be concerned and over which the investigator is expected to have little or no control. They are the cluster of variables associated with the intellectual and cultural backgrounds of adults and including those physical and demographic characteristics of typical concern to educational researchers.

EFFECTS OF PREVIOUS INSTRUCTION

Research studies have produced conflicting statements concerning the value of previous instruction for reasoning logically; moreover, findings reported in the research literature and propositions contained in the speculative literature are not necessarily in agreement on this point. Even within studies classified as "research investigations" there are contradictory reports among studies.

Morgan and Morgan considered the value of "training" in reasoning in developing the theoretical basis for their study. They suggested ". . . rules of logic are basic to science . . ." and because of this fundamental function should have formal status in the curriculum.

Expecting untrained students to think logically, they held, would be analogous to expecting pre-school youngsters to read.[1] They were unable to substantiate these speculations with their research data, finding instead that the group of 67 adults without training in logic did 73% as well as their paired (with respect to sex, age, and college background) partners on the "Morgan Test of Logical Reasoning." All subjects were United States Government employees.

The writings of Wolf and of Henle tend to be supportive of the Morgan and Morgan results. Wolf noted that educators seem to assume that children naturally develop thinking powers as a result of maturation and that reasoning skills do not need to be taught.[2] Henle, subsequent to study of 46 graduate students in psychology, similarly relates formal training to reasoning:

> It must be recognized . . . that the lack of formal training in logic is insufficient guarantee of the naiveté of subjects. It can only be pleaded that we have no better criterion at the present time.[3]

Johnson and Posner, furthermore, found " . . . although some inconsistency was evident in the data, that little if any growth in reasoning ability occurs during the college years, whether or not

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[1]Morgan and Morgan, "Logical Reasoning: With and Without Training," p. 399.

[2]Willavene Wolf, "Logic and Critical Thinking," Educational Leadership 24 (February 1967): 419.

[3]Mary Henle, "On the Relation Between Logic and Thinking," Psychological Review 69 (July 1962): 369.

students take courses in logic."[1] They studied thirty college students using programmed instruction as the vehicle for stimulating growth in eight principles of class reasoning.

On the other hand, McKinnon and Renner[2] tested 131 freshmen at the University of Oklahoma finding that 66 of them did not have the skills to argue logically with given principles in arguments having altered contexts with respect to contexts in which they were learned. In addition, only 33 students were able to meet Piaget's criteria for "formal operations." Inquiry oriented courses, they suggest, will enhance logical thought. They conclude that

> A student may handle concepts quite adequately, but until he has had many manipulative experiences he cannot recognize those concepts in the context of a broader generalization, of which the manipulative experiences and the concepts are simply a subset.[3]

Saadeh cited five studies in support of the proposition that direction and special training, rather than the growing up process, are necessary for development of critical thinking abilities. An understanding of, and a mastery of, the rules and principles of logic gained from instruction were cited as significant for achievement in reasoning.[4]

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[1]Maurice Johnson and George J. Posner, "Testing the Effect of Verbal-Quantitative Aptitude Discrepancy on the Learning of Deductive Reasoning through Programmed Instruction," Final Report, an ERIC typescript having Accession Number ED052633 (Albany, N.Y.: State University of New York, Research Foundation, February 1971), p. 1.

[2]Joe W. McKinnon and John W. Renner, "Are Colleges Concerned with Intellectual Development?" American Journal of Physics 39 (September 1971): 1047-1052.

[3]Ibid., p. 1048.

[4]Ibrahim Q. Saadeh, "The Teacher and the Development of Critical Thinking," Journal of Research and Development in Education 3 (Fall 1969): 87-88.

Saadeh also suggested that " . . . knowledge of any area involved is necessary for thought in that area since its concepts have to be related or correlated for [valid] judgements and [reliable] decision making."[1]

Long and Welch supported this proposition a generation earlier. They proposed that " . . . the more knowledge one has about the [background] elements the more likely will be the occurrence of a solution [for a reasoning problem]."[2] In their individualized testing of elementary students 8½ to 11 years of age, they felt it was " . . . essential to show that the failures on the abstract tests [of reasoning] did not result from ignorance of the concepts employed in these tests."[3]

Henderson found that previous knowledge related to the problem of deciding whether or not an argument is valid significantly helped (alpha = .05) students evaluate a specific argument in a fictitious letter to an editor. He did not state the basis for his comparison--whether he used a control group or some other statistical technique.[4]

A logic of discovery of hypotheses for implementation in "speculative system building" was proposed by McClure. In addition to "psychology" and "history" as modes of studying the two phases of scientific endeavor, which he labels as (1) the "exploratory-discovery" phase and (2) the "confirmatory" or "exploratory" phase, he suggests the

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[1]Ibid., p. 87

[2]Louis Long and Livingston Welch, "Influence of Levels of Abstractness on Reasoning Ability," The Journal of Psychology 13 (January 1942): 42.

[3]Ibid., p. 52.

[4]Kenneth B. Henderson, "Teaching of Critical Thinking," Phi Delta Kappan 39 (March 1958): 280-282. Henderson considers critical thinking to be a task in recognition of logical errors.

"hypothetico-deductive" study-mode associated with logic and philosophy of science.[1] McClure, furthermore, also speculates that a scientist "invents" an hypothesis when immersed in a background or context of theory:

> If we were dealing with primitive levels of scientific development, the "theory" in question might merely be the common sense knowledge of the day. At more sophisticated stages, "theory" is the body of conventional wisdom, common sense and special knowledge accumulated by a given discipline up to the time of the inspiration in question.[2]

Stone and Ausubel found, in 78 seventh graders and 77 high school sophomores, that there are differences in comprehension performance between disciplines rather than synchronous emergence of formal ability across subject matter fields.[3] One of the theoretical considerations supported in Stone and Ausubel's investigation was stated as follows:

> . . . an individual may have attained the formal stage in science if he has had the requisite experience in manipulating concepts concretely in that field, but may still be at the concrete stage in social studies, if parallel experiences in this area are lacking. Situational generality [as proposed by Piaget but countered in Stone and Ausubel's investigation except for the following element of support] is a reasonable expectation, however, after a certain level of ideational experience in a number of subject matter areas and relevant intellectual capacities have been acquired.[4]

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[1]George T. McClure, "Concerning a Logic of Discovery," Educational Theory 20 (Spring 1970): 143-149.

[2]Ibid., p. 148.

[3]Mary Ann Stone and David P. Ausubel, "The Intersituational Generality of Formal Thought," Journal of Genetic Psychology 115 (December 1969): 169-180.

[4]Ibid., p. 170.

The work of Dodd, et alii closely parallels these ideas on instruction in logic. Data for their experiment were collected from 160 student volunteers at the University of Colorado. They found that both prior practice with truth table sorting tasks and prior instruction transfer positively to conceptual rule learning tasks.[1]

The literature is inconsistent in its reports on the effect of science and mathematics on reasoning performance. The only two relevant documents to be uncovered for this review expose the current status of this inconsistency. Sinclair and Tolman reported as follows:

> The correlation of -.08 between the amount of science and mathematics completed in terms of units by the Occidental [College] seniors and the Inference Score, while it is entirely without statistical significance, is at least interesting as indicating no greater ability in drawing correct inferences as a result of the more prolonged study of mathematics and science,--that is, to the extent that the Inference Test is a measure of that ability.[2]

Twenty years later, Morgan and Morgan noted

> It would be desirable to find out what experiences and courses, other than formal courses in logic, increase the student's proficiency in logical reasoning. It is our opinion that some courses, such as mathematics, even though not labeled as courses in logic, may have considerable "carry-over" value to logical reasoning.[3]

Traylor complicates somewhat the complete issue of instructional effects. His research generates a modification for the idea that

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[1]David H. Dodd and others, "Effects of Logic Pretraining on Conceptual Rule Learning," Journal of Experimental Psychology 88 (April 1971): 119-122.

[2]James H. Sinclair and Ruth S. Tolman, "An Attempt to Study the Effect of Scientific Training Upon Prejudice and Illogicality of Thought," The Journal of Educational Psychology 24 (May 1933): 368-369.

[3]Morgan and Morgan, "Logical Reasoning: With and Without Training," p. 401.

reasoning skills can be affected with instruction and intellectual practice by finding that these skills may be differentially extinguished or forgotten when not reinforced over periods of time. He concluded that "time seems to reduce the influence of instruction on the reduction of non-attitude reasoning errors for low authoritarians but the reverse seems to be true for high authoritarians."[1]

Because of the questionable status of influence of previous instruction on productive reasoning, the researcher may be well advised to collect data on this variable for use (1) in statistical control or (2) as a covariate in analysis of reasoning scores or (3) as a source of variation in ANOVA designs.

EFFECTS OF EX POST FACTO VARIABLES

Cultural Background. It is widely recognized in contemporary thought that variations among cultural backgrounds represented in population sub-groups may lead to interpretational and generalizational inaccuracies for collected data. In fact, culture-fair considerations have achieved such widespread credibility in social science research that an investigation may be suspect if contributions of, and corrections for, cultural variables are omitted. While the precise cultural variables requiring attention within a specific study are often elusive, the superimposition of cultural contexts on analyses of reasoning data easily leads to obvious focal points associated with those cultural

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[1]Elwood B. Traylor, "Authoritarianism and Time as Influence on Decision Making," final report, an ERIC typescript having Accession Number ED044395, (Wichita: Kansas State University, College of Education, February, 1969), p. 37.

influences inherent in translating argumentative forms, with their logical connectives, into logically consistent conclusions. Culture, that which is constitutive of the person's environment from his birth, may be thought of in this frame of reference as "the silent translator" motivating the thinker to respond to a given verbal stimulus situation with any one of a set of diverse behaviors. In this sub-section, therefore, there is an attempt to reflect those considerations from the literature that appear to have value for determining the culture-boundness of logical connectives and argument interpretations.

Whatever is perceived seems to depend on the observer's cultural-perceptual frame of reference. Logic, as a factor dependent upon perception, is a cultural phenomenon as well. As Kaplan has stated it,

> Logic (in the popular, rather than the logician's sense of the word) . . . , is evolved out of a culture; it is not universal. . . . . The English language and its related thought patterns have evolved out of the Anglo-European cultural pattern. The expected sequence of thought in English is essentially a Platonic-Aristotelian sequence, descended from the philosphers of ancient Greece and shaped subsequently by Roman, Medieval European, and later Western thinkers. It is not a better nor a worse system than any other, but it is different.[1]

Three differences cited by Kaplan from analysis of 600 student compositions in "English as a Foreign Language" classes are (1) foreign languages employ different rhetorics and sequences of thought than native English, (2) certain linguistic structures within specific languages are themselves best comprehended as "embodiments of logical structures," and (3) thought patterns differ among languages. With

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[1]Robert B. Kaplan, "Cultural Thought Patterns in Intercultural Education," Language Learning 16, Nos. 1 & 2 (1966): 2-3.

respect to thought patterns, English is usually linear within each paragraph either from a topic sentence or to one, Arabic is a complex series of both positive and negative parallel constructions, some Oriental language paragraphs are marked by circular analyses of series of tangential views developed in terms of what the topic is not, French and Spanish paragraphs typically contain extraneous digressions from the basic thought of the paragraphs, and Russian paragraphs are frequently composed of irrelevant parenthetical amplifications of subordinate structures.[1] Kaplan suggests that this shows " . . . that part of the learning of a particular language is the mastering of its logical system."[2] In another place, this principle is reemphasized: one can only understand the whole context of paragraph and larger units " . . . if he recognizes the logic on which the context is based."[3]

Horn, responding to Kaplan's work with the cultural aspects of logic in teaching English to foreign students, examined "about 500 paragraphs" for systematizing logical relationships categorically.[4] She found 18 categories to be sufficient for classifying the relationships between all sentence pairs within paragraphs and to be sufficient for teaching English expository relationships to foreign students. While her categories were workable, she speculated that "logicians undoubtedly could find much to quibble about in the classifying that was done, ..."[5]

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[1]Ibid., pp. 4-14. [2]Ibid., p. 14. [3]Ibid., p. 15.

[4]Vivian Horn, "Teaching Logical Relationships in Written Discourse," TESOL Quarterly 3 (December 1969): 291-296.

[5]Ibid., p. 293.

Mills also wrote on the interactive nature of logic with culture. Two of his opinions are pertinent:

1. "A symbol has a different meaning when interpreted by persons actualizing different cultures or strata within a culture."

2. There is an non-uniform tradition associated with symbols that manifests itself in the "linguistic reflex of the socially controlled behaviors from which a scholar is derived, which he "lives" (behaviorally or vicariously), or which constitutes the audience of his thought, or all three.[1]

In terms of application of the concept of the social nature of thought to experiments in reasoning, another comment by Mills seems to be relevant:

> We can socially functionalize a given thinker's production only when we have made explicit, and systematically applied, a sound hypothesis of the specific sociopsychologic mechanisms by which cultural determinants are operative.[2]

The instability of logical constructions between cultures having different native languages has also been recognized in the literature of foreign language instruction to English speaking students. The writings of Twaddell, Politzer, Méras, and Decanay will be referenced to illustrate this point.

As an element in his analysis of conflict points between one's native-language and a language learned later, Twaddell asserts a prevailing principle for foreign language teaching:

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[1]C. Wright Mills, "Language, Logic, and Culture," American Sociological Review 4 (October 1939): 678-679.

[2]Ibid., p. 672.

> The learner of a second [language] makes mistakes and misunderstands because his native-language . . . habits are interfering and conflicting with the habits of the FL [foreign language].[1]

Mistakes due to conflict points may appear in the linkage of any linguistic aspect between the two languages, including the logical consistency aspect of connected discourse.

Politzer is more specific in his analysis of the relation of logical considerations to foreign language instruction:

> For many centuries our views of grammar and L[anguage] were dominated by the idea that there is a basic identity between grammatical and logical categories.
> . . . . . .
> Within the 20th cent[ury], the idea of universal logical grammar was rapidly abandoned and attacked by the ling[uistic] scientist.[2]

For those who prepare materials for use in foreign language instruction, Méras advises avoidance of textual allusion to historical and cultural material not clearly comprehendable from context.[3] Independent emphases of this point are provided by Dacanay:

> . . . the meaning the pupil gives to his reading evolves from his own past experience with the spoken forms. If he has had no previous experience with the concepts and the grammatical structures, he may not understand or may understand imperfectly what he has read. (pp. 277-278.)

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[1]W. Freeman Twaddell, "Linguistics and Foreign Language Teaching," The Teaching of German: Problems and Methods, an anthology edited by Eberhard Reichmann (n.p.: Teaching Aid Project, National Carl Schurz Association, Inc., 1970), p. 62.

[2]Robert L. Politzer, "The Impact of Linguistics on Language Teaching: Past, Present and Future," The Teaching of German: Problems and Methods, an anthology edited by Eberhard Reichmann (n.p.: Teaching Aid Project, National Carl Schurz Association, Inc., 1970), p. 57.

[3]Edmond A. Méras, "Teaching Reading," A Language Teacher's Guide, 2nd ed. (New York: Harper & Brothers, Publishers, 1962), Chapter XI, pp. 190-205 passim.

> . . . different shades and nuances of meaning . . . are appropriate to and taught by a particular context . . . . (Examples abound in idiomatic expressions as] . . . the meanings of these cannot be taken from the words that made up the idioms, though here again context may teach the proper meaning. (p. 298.)
>
> . . . no understanding . . . can be possible unless we have some knowledge of the culture in which . . . language operates. (p. 300.)[1]

The literature did not reveal whether languages other than English contain ambiguities in logical connectives and qualifiers. It is not known from this search whether other languages have an equivalent for "or" with English meanings in one case "one or the other or perhaps both" and in another case "one or the other and not both," or have an equivalent for "some" having popular connotation "only some and not all" or the logical scope of "some and perhaps all."

There was one document suggesting that cultural patterns affect thought even within groups of native speakers of the same language. Examining the issue of affect of ability to use English on critical thinking, Miller, Follman, and Hernandez obtained data on ninth graders in Hillsborough County, Florida. White, black and integrated schools were found to be differentiable on the basis of the "Watson-Glaser Critical Thinking Appraisal" and the "Cornell Critical Thinking Test."[2]

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[1]Fe R. Dacanay, "Reading English," Techniques and Procedures in Second Language Teaching, ed. by J. Donald Bowen, Philippine Center for Language Study Monograph Series, No. 3 (Quezon City, Philippines: Phoenix Publishing House, 1963), Chapter IV, pp. 240-305.

[2]John Follman, William Miller, and David E. Hernandez. "Discriminant Analysis of Scholastic Aptitude and Critical Thinking Tests and Levels of 'Disadvantagement,'" a paper presented to the Joint Annual Meeting of the American Educational Research Association and the National Council on Measurement in Education, Minneapolis, Minnesota, March, 1970; an ERIC typescript having Accession Number ED041047, p. 4.

In addition, if authoritarianism is a variable having inherent cultural roots then it is an intervening variable along the path of culture to decisions about arguments. Thistlethwaite's study[1] and Traylor's subsequent reinvestigation[2] of the phenomenon lend support to the generalization that subjects higher in authoritarianism traits have greater tendencies to distort arguments.

Occupational Role. Kerlinger examined 25 subjects on the basis of their known occupational roles and known attitudes toward education. There were 10 liberal arts professors, 8 education professors and 7 outside persons. He hypothesized that individuals having the same or similar occupational or professional roles would respond similarly to sets of questions related to their respective roles and that individuals having dissimilar roles would respond differently. The results of his analyses confirmed the hypothesis.[3]

There will be a later, more in-depth examination of the function of attitude reaction to conclusions for arguments. Meanwhile, Kerlinger's study suggests that occupational role, perhaps through its effect on a subject's attitude to arguments presented in a questionnaire, is a variable that may account for a portion of the variation

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[1]Donald Thistlethwaite, "Attitude and Structure as Factors in Distortion of Reasoning," The Journal of Abnormal and Social Psychology 45 (July 1950): 442-458.

[2]Traylor, "Authoritarianism and Time as Influences on Decision Making," pp. 17 and 37.

[3]Fred N. Kerlinger, "The Attitude Structure of the Individual: A Study of the Educational Attitudes of Professors and Laymen," Genetic Psychology Monographs 53 (May 1956): 283-329.

in deductive reasoning skill among adults. Furthermore, Kerlinger's discussion of occupational role stimulates the following questions in terms of reasoning measurements:

> Will individuals differ, as a function of their respective occupational roles, in the accuracy with which they respond to arguments having argumentative content based on education?
>
> Will there be differences among individuals in the accuracy of their responses to educational arguments according to their educational predilections within the education sub-professions? (Will there be departmental differences within a School of Education?)

Intelligence. In a classic experiment on syllogistic reasoning Wilkins observed that:

> There is a marked correlation, though not a high one, between success on the syllogism test and success in the Thorndike Intelligence Examination. The correlation between the Thorndike Intelligence Examination and success with the symbolic material is decidedly higher than with any of the other kinds [unspecified] of material used.[1]

This observation was based on data collected from eighty-one undergraduates of Columbia College.

Some years later, Sells, in another classic study, did not state as strongly the case for dependence of syllogistic reasoning on intelligence. The magnitude of correlation between syllogism test scores and intelligence test scores, he wrote,

> . . . is undoubtedly a function of the subjects used, the form of the syllogism test, the form of the intelligence test, the amount of time given to the subjects on each test, and the methods of scoring. . . . Thus the correlation of the abstract [syllogism reasoning scores] with intelligence [scores] is demonstrated to be spuriously high when the effect of the verbal

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[1]Minna Cheves Wilkins, "The Effect of Changed Material on Ability to do Formal Syllogistic Reasoning," Archives of Psychology No. 102 (November 1928): 77.

> factor [concrete scores] is controlled [through partial correlation]. This result provides experimental support for Spearman's . . . statement that "the formal logic of syllogisms, when stripped of accessories and thus reduced to, one might think, the very quintessence of 'intellect,' in point of fact exhibits not a perfect, but a poor correlation with intelligence as measured in any other way."[1]

Sinclair and Tolman arrived at a different conclusion. A consequence of their study at Occidental College is the statement:

> An evaluation of the coefficients [of correlation] found indicates that the correlation between Thorndike [Intelligence Examination] scores and Inference scores for the Occidental freshman ($-.49 \pm .07$) has significance and suggests that intelligence favors superiority in inference-making ability.[2]

Nearly a score of years later, in 1953, Morgan and Morgan summarized their perception of the then current status of the problem:

> We have found in other studies that scores on tests of logical reasoning always correlated positively, often substantially, and sometimes very highly with scores on group tests of intelligence such as the Henmon-Nelson, the Thurstone ACE, the Miller Analogies, ... We are, therefore, inclined to suggest that the ability to think logically is, to a certain degree, an aspect of intelligence.[3]

Subsequently, Rott, *et alii* found in subjects through the twelfth grade that "correlations of student scores on the verbal argument tests with student scores on [the] intelligence . . . test tend to be low to moderate."[4]

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[1]Saul B. Sells, "The Atmosphere Effect: An Experimental Study of Reasoning," *Archives of Psychology* No. 200 (May, 1936): 23-25.

[2]Sinclair and Tolman, "An Attempt to Study the Effect of Scientific Training Upon Prejudice and Illogicality of Thought," p. 368.

[3]Morgan and Morgan, "Logical Reasoning: With and Without Training," p. 401.

[4]Robert K. Rott, and others, "Student Abilities in the Evaluation of Verbal Argument: A Normative Study," Technical Report No. 106, an ERIC typescript having Accession Number ED038404, Madison, Wisconsin: Wisconsin Research and Development Center for Cognitive Learning, November, 1969), p. ix.

It seems that no clear generalization can be drawn from the literature concerning the dependency of reasoning on intelligence beyond the fact that the relationship seems to be unsettled.

Sex. Roberge and Paulus found nonsignificant sex differences within a group of 228 students in 6th, 8th, and 10th grades when analyzed with respect to their type of reasoning and content dimension scores.[1] Their data permitted them to make the following statement:

> The nonsignificant ($p \leq .05$) F ratios for the factor sex . . . and its interactions . . . indicated that the sex of the student was a negligible factor in the development of logical reasoning ability for the students tested in this investigation.[2]

Weinstock and Turner measured the logical consistency of 318 St. Louis and St. Louis County teachers with the GNC scale which they characterized as follows:

> The GNC [Gowin, Newsome, Chandler] scale is designed to measure (1) which of the two major philosophical purports (i.e. empiricism or rationalism) an individual holds with regard to education and (2) how consistent he is in logically relating his theoretical educational aspects (i.e. nature of the universe, man, and mind) to his practical educational aspects (i.e. views on methods, curriculum, and evaluation) within one of these two Weltanschuungen (philosophical "world-outlooks").[3]

Weinstock and Turner found no significant difference between male and female teachers in terms of these GNC scores.[4]

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[1] James J. Roberge and Dieter H. Paulus, "Development Patterns for Children's Class and Conditional Reasoning Abilities," Developmental Psychology 4 (March 1971): 191.

[2] Ibid., p. 196.

[3] H. R. Weinstock and H. E. Turner, "Philosophic Orientation, Logical Consistency, and Teaching Attitudes of Urban and Suburban Teachers," a paper presented at the Annual Meeting of American Educational Research Association in Minneapolis, Minnesota, 1970; an ERIC typescript having Accession Number ED040128, p. 3.

[4] Ibid., p. 7.

Age. The GNC scale, with the same group of teachers, was used for investigating age differences. In their analysis, Weinstock and Turner suggested that those age differences found

> could be indicative of (1) more empirical and logically consistent courses taken by the younger groups, (2) a GNC scale "success" factor being based on the recency of course work, or, perhaps (3) an adverse effect on logical consistency related to years of actual teaching experience.[1]

In an earlier study, Sells was able to state that

> . . . while there probably is a decline in ability to reason (i.e. to solve syllogisms) with advancing age, neither the correlations nor the obtained error distributions show any significant differential influence of age on atmosphere effect.[2]

Yudin, studying 36 males of ages 12, 14, and 16 in a small Massachusetts town of about 20,000 people, obtained results that are inconsistent with the Weinstock and Turner, and Sells reports above. Yudin, using an ANOVA design with his group of white middle class subjects, obtained results indicating

> . . . that the development of formal thought in adolescence is an interaction of age and intelligence. . . . Further, concepts of number are significantly more difficult to attain than either concepts of color or form, but no significant differences are noted between the latter two.[3]

King worked with groups of males and females at ages 6, 9, and 12, and also with college students finding that "disjunctive rules were more

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[1]Ibid., p. 9.

[2]Sells, "The Atmosphere Effect: An Experimental Study of Reasoning," p. 46.

[3]Lee William Yudin, "Formal Thought in Adolescense as a Function of Intelligence," Child Development 37 (September 1966): 697.

difficult than conjunctive ones for all age levels,"[1] and that generally the relative rule difficulty difference increases with decreasing age.[2]

O'Brien and Shapiro were concerned with an elementary school age group--1st, 2nd, and 3rd graders in a suburban Cleveland parochial school. They measured 25 subjects for "logical necessity" of conclusions from sentential logic, classical syllogism, and logic of quantifications. They felt measures of logical necessity to be "vital to an adequate consideration of hypothetico-deductive reasoning."[3] In their discussion they noted that:

> It would seem that . . . children of ages six, seven, and eight have considerable success in recognizing logically necessary conclusions. They "peak out" high and early in this ability. Children of the same age, however, experience great difficulty in testing the logical necessity of a conclusion, and they show slow growth in this ability.[4]

Fletcher focused his efforts on the ability of 6th, 10th, and 14th graders to synthesize conditionals under laboratory conditions which did not include printed stimuli. He found that performance increased monotonically across all age groups.[5]

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[1]William L. King, "Learning and Utilization of Conjunctive and Disjunctive Classification Rules: A Developmental Study," Journal of Experimental Child Psychology 4 (November 1966): 228.

[2]Ibid., p. 230.

[3]Thomas C. O'Brien and Bernard J. Shapiro, "The Development of Logical Thinking in Children," American Educational Research Journal 5 (November 1968): 533.

[4]Ibid., p. 537.

[5]Harold J. Fletcher, "Toward a General Model for Describing Cognitive Processes," Theoretical Paper 23, Terminal Report from the Rule Learning Project of the Research and Development Center for Cognitive Learning; an ERIC typescript having Accession Number ED043087, (Madison, Wisconsin, December, 1969), pp. 1-21.

Karplus and Karplus also found a direct relationship for age with reasoning. Their "Island Puzzle" study involving 449 subjects from grade 5 to science teachers indicated that intellectual development in abstract reasoning is a gradual phenomenon. After grade 9 little further progress occurs. They made the following comment about their study:

> Even though one can conceive other . . . ways of posing the logical task . . . we believe that this preliminary study calls attention to a neglected area of educational research which has significant bearing on large scale improvements in assessing scientific literacy [of high school and adult populations].[1]

In a subsequent report, Karplus and Karplus were more specific about the influence of maturation. They reported that answers categorized by them as "abstract thought" were not produced by fifth and sixth graders; but that type of response did appear in tenth grade subjects, was more frequent in twelfth grade physics students, and was most abundant from physics teachers participating in NSTA or belonging to the American Association of Physics Teachers.[2] No other teachers were examined.

Reasoning Habits. Thorndike's psychology defines reasoning " . . . as the organization and cooperation of habits rather than as a special activity . . . and expects to find 'reasoning' and habit or

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[1]Elizabeth F. Karplus and Robert Karplus, "Intellectual Development Beyond Elementary School: I. Deductive Logic," an ERIC typescript having Accession Number ED033854, (Berkeley: California University, Science Curriculum Improvement Study), p. 7.

[2]Elizabeth F. Karplus and Robert Karplus, "Intellectual Development Beyond Elementary School, I. Deductive Logic," School Science and Mathematics 70 (May 1970): 398-407.

association working together in almost every act of thought."[1] Mills independently extended this view to include considerations for one's reaction to the products of his reasoning, whether he approves or critically disapproves of them. Toward this end, Mills contended that:

> One operates logically (applies standardized critiques) upon propositions and arguments (his own included) from the standpoint of a generalized other. It is from this socially constituted viewpoint that one approves or disapproves of given arguments as logical or illogical, valid or invalid . . . .
> . . . . . .
> Our logical apparati are formulated by the rebuffs and approvals received from the audiences of our thought. When we converse with ourselves in thought, a generalized other as the carrier of a socially derived logical apparatus restricts and governs the directions of that thought.[2]

Thought, in this respect, seems to be a habitual lingual performance of an individual thinker--a performance that is couched in his history of argumentative successes with his friends, family, or colleagues. The thinker may tend to apply those standards to his thoughts that will cause his conclusions to be in agreement with the thinking of those he wishes to convince; that is, tend to manipulate his thought into the mold corresponding to his generalized conception of "good" reasoning. According to Mills, as one shifts his interests and as he matures, his standards of judgment are also altered:

> The rules of the game change with a shift in interests, and we must accept the dominant rules if we would make an impress upon the profile of thought.[3]

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[1] Edward L. Thorndike, "The Effect of Changed Data Upon Reasoning," Journal of Experimental Psychology 5 (February 1922): 33.

[2] Mills, "Language, Logic, and Culture," pp. 673-674.

[3] Ibid., p. 674.

More contemporarily, Weinstock, et alii treat the question of internal consistency as a factor in reasoning. Using the GNC Scale of Logical Consistency in Educational Ideas they determined philosophic orientation for samples of Kansas State University and Northeastern (Oklahoma) State College students. Their data suggested that "low logical consistency may signify disagreement between theoretical and practical educational views"[1] suggesting that logically inconsistent subjects may experience difficulty in defining the specific criterial rules from their theoretical history that should be followed in the practical situations proposed by their environmental stimuli, including testing devices or questionnaires.

INSTRUMENT FACTORS

A second cluster of factors, in addition to the various classification factors discussed above, may be considered to intersect with each other in that all have in common the property of being associated with the particular instrument chosen or constructed for measuring ability to assess and complete arguments. The discussion of variables that follows assumes certain conventions or constants to hold across the arguments composing whatever instrument is used: (1) that there will be consistent grammatical conventions holding within arguments, (2) that the warranting premise(s) for a conclusion will assume a constant, standard form and a standard order preceeding the conclusion, (3) that the instructions given the examinee will be

[1]Henry R. Weinstock, and others, "Logical Consistency of Student Teachers in Different Educational Environment," Journal of Experimental Education 37 (Spring 1969): 78.

straightforward, applicable to each argument and unambiguous, and (4) that there will be no interaction between instrument and examinee such that the examinee learns to draw logically consistent conclusions while being measured with the instrument.

EFFECTS OF LOGICAL CONNECTIVES

This analysis is directed mainly to "simple connectives." There will be no focused attempt to review the literature on "compound" relations found in propositions combining two or more simple connectives. The logical connective literature researched represents the conditional, conjunction, and disjunction. The negation is also included. No research was uncovered for the biconditional and the negajunction.

There seem to be sets of inferential possibilities associated with the use of each logical connective within each logical system, for example, within the Ennis system, the Polish system, or the Gardiner system. Furthermore, within a particular system, logical connectives may be either context-free or context-variant. Concerning these properties, Anderson and Mortensen made the following statement:

> What has not been sufficiently acknowledged . . . is that under certain linguistic conditions discourse may well contain all necessary substantive features of an "argument," meeting the codification requirements of a given logical system, and yet still not be amenable to the scrutiny of a public logic. Given the full powers of language, much . . . argument may be simply beyond logic.[1]

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[1]Ray Lynn Anderson and C. David Mortensen, "Logic and Marketplace Argumentation," Quarterly Journal of Speech 53 (April 1967): 143.

Gardiner observes that there are nine possible relations specifying the factual interactions possible for two components joined through logical connectives into two-component sentences. These relations connote the truth values of one component, symbolically "q," as the second component, symbolically "p," assumes first a status of "true" then a status of "false" as represented in Table 1. Three rows of the table represent logical independence; since the truth status of either component in these rows is not affected by the assertion or denial of the other. Some of the labels used in Ennis' logic and elsewhere in this proposal coordinate with relations identified by Gardiner. The third and fourth columns of Table 1 provide a cross-reference between the two systems of logical nomenclature.

Gardiner also provides a comprehensive definition for the concept of "logical operator." Beginning with the tautology,

$$(p \wedge q) \vee (p \wedge \bar{q}) \vee (\bar{p} \wedge q) \vee (\bar{p} \wedge \bar{q}),$$

Gardiner notes that

> The English language has provision for the elimination of all possible subsets of alternatives within the tautology. . . . The words or groups of words which perform this function will be called "logical operators."[1]
>
> . . . . . .
>
> Whereas the tautology . . . is universal, the [grammatical or operationall means of eliminating subsets of alternatives is specific to each language. Do all languages have logical

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[1]William Lambert Gardiner, "An Investigation of Understanding of the Meaning of the Logical Operators in Propositional Reasoning" (Ph.D. dissertation, Cornell University, 1966; Ann Arbor, Mich.: University Microfilms Number 66-4,109), p. 7.

TABLE 1

NINE RELATIONS BASED ON THEIR COMPONENTS

Truth status of q when p is asserted	Truth status of q when p is denied	Name in Ennis system	Typical logical name *a la* Gardiner	Typical form of English expression
True	True	- - - -	Independence	- - - -
True	False	Biconditional	Equivalence	p if and only if q.
True	Uncertain	Conditional	Superimplication	If p, then q.
False	True	Strong alternation	Contradiction	Either p or q.
False	False	- - - -	Independence	- - - -
False	Uncertain	Negajunction	Contrariness	Not both p and q.
Uncertain	True	Weak alternation	Subcontrariness	Either p or q or both.
Uncertain	False	Conditional	Subimplication	If q, then p.
Uncertain	Uncertain	- - - -	Independence	- - - -

Source: William Lambert Gardiner, "An Investigation of the Meaning of Logical Operators in Propositional Reasoning," (unpublished Ph.D. dissertation, Cornell University, 1965; Ann Arbor, Mich.: University Microfilms Number 66-4109), p. 9; and Robert Ennis, Logic in Teaching.

> operators like English's "if--then" which does duble duty? . . . Do all languages have logical operators as English to eliminate all subsets or are there languages which do not and are therefore less amenable to the emergence of logic and mathematics?[1]

Anderson and Mortensen draw generalizations in their analysis of argumentation that seem to be valuable for evaluating research arguments from fields reflecting the natural history state of development. They write:

> Only if the critic [evaluator of an argument] understands the meanings of . . . logical connectives is he able to calculate the relationships among different argumentative propositions. Thus a knowledge of the logical connectives within a logical system [for example, that system which Ennis associates with teaching] is a necessary condition for determining the validity of argument under consideration.[2]

Shifts in lexical meanings of propositions may occur with the replacement of less stable connectives, the context-variant connectives, of ordinary language with the context-invariant connectives associated with a particular system of logic. Consequently, an instrument for measuring reasoning should use invariant connectives that are so strictly defined in a formal logical system that the validity of inferential leaps between premises and conclusions may be clearly specified.

In order to maintain some measure of context-invariancy in an argument, one should build the argument with propositions that do not have context-dependent properties; that is, he should build arguments that do not contain connectives given to subjective interpretations.

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[1]Ibid., p. 32.

[2]Anderson and Mortensen, "Logic and Marketplace Argumentation," p. 144.

More specifically, the more context-invariant arguments would not be based on non-analytic propositions such as (1) commands, (2) reproaches, (3) questions, (4) laments, (5) exhortations, and (6) plaudits; such that the warranting meanings supporting the arguments would have sufficient similarity across qualified critics that there would be maximum consistency in their evaluations of the arguments. Thereby, the options for subjective interpretations are more or less removed and, with them, personal concepts for validity are minimized.

As research becomes inspired by deductively formulated theories, however, the possibilities for context-variant connectives become more remote. Johnson analyzes the problem as follows:

> No artful manipulation of symbols according to prescribed rules can make good logic out of bad logic, or produce a proof of the validity of any procedures which are invalid by the postulates and rules of a genuine logic. The structure of science as we know it is pre-determined by the definitions, postulates, and rules of manipulation of symbols that we call modern logic.[1]

The particular symbols over which Johnson draws this analysis represent "propositions," "events," and "relations," with relations being that class of terms elsewhere referred to in this proposal as "logical connectives."

By reducing nine relations (connectives) to five relevant ones and from those five generating 12 rules for combining propositions into arguments, Gardiner constructed an instrument for measuring logical performance. He translated each rule of the twelve rules of argumentation into six instrument items. To these 72 items he

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[1]H. M. Johnson, "If-then Relations in Paralogics," Psychological Review 51 (January 1944): 74.

added six items for each of two specified combinations of two rules thereby synthesizing a total test of 84 questions. Each item was projected from a 35 mm slide for 17 seconds to 277 subjects from grades 4 through 12 in the Ithaca school system and from introductory psychology courses at Cornell. The symbolic arguments for the 12 single rules and for the 2 specific combinations of two rules were referred to as 14 "variations of form." Gardiner found variation of form to be a significant effect ". . . interpretation in terms of differential understanding of the rules which are embodied in each form."[1] This finding represents support for the notion that people are not equally effective with arguments containing variations in logical connective types.

Thistlethwaite claimed in 1950 that ". . . . no attempt has previously been made to consider the effect of defined degrees of logical 'structure' upon reasoning.[2] Thistlethwaite conceived of "structure" in terms of "form." By "form," he connotes one of six arbitrary types of argument which he clustered under "conditional reasoning." These six forms[3] were

1.	$p \rightarrow q$	premise	2.	$p \rightarrow q$	premise
	$\underline{-p}$	premise		$\underline{p \rightarrow r}$	premise
	$-q$	invalid conclusion		$q \rightarrow r$	invalid conclusion

[1]Gardiner, "The Investigation of Understanding of the Meaning of the Logical Operators in Propositional Reasoning," p. 16.

[2]Donald Thistlethwaite, "Attitude and Structure as Factors in the Distortion of Reasoning," p. 442.

[3]Ibid., pp. 444-445.

3. $p \rightarrow q$ premise
q premise
p invalid conclusion

4. $-p \rightarrow q$ premise
$-r \rightarrow s$ premise
$p \rightarrow -s$ premise
$q \vee r$ valid conclusion

5. $(p \quad q) \rightarrow r$ premise
$-q \rightarrow s$ premise
$-r$ premise
s valid conclusion

6. $p \rightarrow q$ premise
$q \rightarrow r$ premise
$p \rightarrow r$ valid conclusion

A respondee would be assigned integers on a defined "scale of structural orders" such that for each form or structure values between 0 and 7 would indicate his tendency to judge neutral items as valid or invalid.[1] Thistlethwaite summarized the properties of his scale as follows:

> To summarize, a scale of structures was defined consisting at one end of those forms of inference consistently judged invalid [by 559 subjects from 7 universities] and at the other end of those consistently judged valid. [There were seven steps from order 0 to order 6.] The intermediate scale positions represent structures of lesser degree than those found at either end, while at the midpoint of the scale are found ambiguous structures which lead to judgments of validity and invalidity equally often. By comparing scores on emotional arguments of different degrees and directions of structure it is possible to determine how distortion of reasoning varies with structural properties . . . . The number of errors on neutral items may be taken as a measure of the cues derived by the subject from the formal patterns and grammatical properties of the arguments. Judgments on the emotional arguments will presumably be based on these same cues and in addition on attitudes evoked by the content of the items.[2]

Considering distortion to be defined as the difference in number of errors between emotional-content and neutral-content scores--

distortion = (emotional score - neutral score) errors--

Thistlethwaite found that " . . . as the structure of the form becomes increasingly compatible with prejudiced responses the degree of relative distortion increases," and that "the empirical results of the

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[1] Ibid., pp. 446-447.

[2] Ibid., p. 447.

present experiment and the analysis of structure as an entity which may possess direction [that is, as a scaled property], taken together, strongly suggest that the unique status accorded ambiguous structures as means of evoking attitude is based upon convenience rather than upon empirical and rational grounds."[1]

Negation. Roberge, in one study, explored the effects of negation on adults' abilities to do conditional reasoning with two valid and two invalid argument forms. He concluded that adults " . . . find conditional arguments with affirmative and negative conclusions equally easy to reason with."[2] (Emphasis mine.) It was, rather, the affirmative or negative nature of the conditional premise components that determined the ease with which adults reason through an argument. The conditional premise components were controlled to vary systematically--(1) affirmative antecedent with affirmative consequent, (2) affirmative antecedent with negative consequent, (3) negative antecedent with affirmative consequent, and (4) negative antecedent with negative consequent. Moreover, the conclusions were likewise controlled varying from negative to affirmative.

Roberge's efforts might be criticized in that--

1. his 40 item instrument used symbolic premises rather than propositional statements that one would expect to encounter in ordinary argumentation, and
2. only four premise formats (each a conditional) by two conclusion types were examined.

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[1]Ibid., p. 458.

[2]James J. Roberge, "Some Effects of Negation on Adult's Conditional Reasoning Abilities," Psychological Reports 29 (December 1971): 843.

In fact, Roberge's discussion acknowledged that "the effects . . . on adults' abilities to reason with other types of propositional reasoning schemes, e.g. disjunctive, need to be explored."[1]

De Mille also considered logical and empirical oppositeness. In his opinion "there is . . . no necessary correspondence between the language of logical opposition and the empirical degree of oppositeness that will be revealed by a particular method of observation."[2] Nevertheless, he suggests that oppositeness is a major factor in conceptualization and that it is not possible to predict its effect on thinking.

Paulus summarized the effect of negation on assessing and judging scores for 165 upper New York state school children as follows:

> . . . the presence of negation in the premises of arguments does not affect subjects' abilities to deduce nor their abilities to assess the conclusions of deductive arguments.[3]

Conditional. Johnson describes four if-then relations, each of which is reflexive (self-sufficient), non-symmetrical (not necessarily reversible), transitive (chains), and many-many (a consequent may have many interchangeable antecedents). He labels these relational connectives as (1) "material implication," (2) "strict implication," (3) "eventual causality," and (4) "intrinsic causality." The first two are associated with propositions, the last two with events with

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[1] Ibid.

[2] Richard DeMille, "Logical and Empirical Oppositeness in Value Responses," Psychological Reports 26 (February 1970): 143.

[3] Dieter Helmut Paulus, "A Study of Children's Ability to Deduce and Judge Deductions," (dissertation, Cornell University, June 1967; Ann Arbor, Mich.: University Microfilms No. 67-16,365), p. 130.

the understanding that events are described by propositions.[1] One may establish the truth of statements utilizing the if-then connective by census of events if the experience has ended (is closed) or by induction if the experience is continuing.[2] Thereby one verifies the existence of a one-one correspondence between the class of events and the class of propositions, the happening of an event corresponding to the truth of its describing proposition.

> . . . whenever one class of terms stands in a one-one correspondence with another class of terms, term for term and relation for relation [as between events and propositions], then every assertion about the interrelations of the terms in one class can be "transformed" or translated into a corresponding assertion about the interrelations of the terms in the other class. And the proof of any proposition in the one system can be transformed into a proof of the corresponding proposition in the other system.[3]

Ennis examined logical abilities of young children finding " . . . that there are vast differences in the mastery of the various principles [of conditional logic]."[4] He studied 187 children in the first three grade levels of rural, urban, and suburban New York state schools under the assumption that " . . . conditional logic is crucial to deductive logic, and deductive logic is crucial to critical

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[1] Johnson, "If-then Relations in Paralogics," 71-72.

[2] H. M. Johnson, "Rival Principles of Causal Explanation in Psychology," The Psychological Review 46 (November 1939): 495-496.

[3] Ibid., pp. 497-498.

[4] Robert H. Ennis, "Conditional Logic and Primary Children," a mimeographed pre-publication version of a paper prepared for presentation to AERA on March 6, 1970; an ERIC typescript having Accession Number ED038186, (Ithaca, New York: Cornell University, 1970), p. 3.

thinking."[1] Although his procedures did not investigate more than inversion, conversion, contraposition, and transitivity properties of conditional reasoning he was able to suggest that students can handle propositional logic earlier than the ages of 11 or 12 predicted by Piaget. One might criticize Ennis' investigation, however, in that--

1. his study is based on having children sometimes reason from untrue premises related to science,
2. his procedures apparently did not control for subjectivity in measuring oral statements of respondees,
3. he gave credit for an item "only if the right answer and a good justification were both given"[2] (emphasis mine) (the criteria for excellence in justifications were not reported),
4. he did not control for probable subject-experimenter interaction during the oral testing of his subjects, and
5. he worked with conditional reasoning only.

Roberge and Ennis compared conditional with class reasoning. They found a significant difference ($p \leq .05$) between the two types among children at various grade levels with the greater reasoning ability being associated with class reasoning. With 228 fourth-, sixth-, eighth-, and tenth-graders, Roberge and Ennis were able to state

> An examination of the means associated with the significant ($p < .01$) Grade Levels X Types of Reasoning interactions revealed that differences between the means for each type

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[1] Ibid., p. 2.

[2] Ibid., p. 5.

> of reasoning were smallest at the fourth-grade level and that neither type of reasoning was consistently easier at all grade levels.[1]

Whether these observations would extrapolate to college undergraduate and graduate students in the various academic disciplines is not known.

Miller investigated eighth-, tenth-, and twelfth-grade students in four randomly selected Wisconsin high schools having less than 300 students in their graduating classes. Relevant sources investigated were (1) intelligence at three intellectual ability levels, (2) interactions at 24 possible "pattern" by "content" classifications, and (3) logical connectives or "patterns" at six levels. The six pattern levels are (1) law of detachment, (2) contrapositive inference, (3) hypothetical syllogism, (4) disjunctive syllogism, (5) affirming the consequent, and (6) denying the antecedent. Five of these patterns are variations within conditional reasoning and the sixth, the disjunctive syllogism, has the form

P or Q	Premise
not P	Premise
Q	Valid Conclusion

Each pattern was measured with 20 items representing 4 content types on Miller's instrument: (1) five symbolic, (2) five with premises agreeing with physical world situations, (3) five with some premises violating physical world situations, and (4) five with premises being nonsense statements. Each argument was constructed with premise statements above a line and three multiple conclusion options below the line. The three choices were (1) the valid conclusion for valid

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[1]Roberge and Paulus, "Developmental Patterns for Children's Class and Conditional Reasoning Abilities," p. 196.

patterns or the usually accepted conclusion for invalid patterns, (2) the negation of the valid or usually accepted conclusion, and (3) "Neither 1 nor 2 necessarily follows."[1] The respondee was asked to select from the three given options rather than to submit "yes" or "no" because in tests answered with yes-no, "it is this investigator's [Miller's] opinion that the correct answer was arrived at, not because the pattern was recognized as valid, but, rather because the desired invalid response was not provided."[2]

Miller sumarized his findings as follows:

> The analysis of the test shows a relatively low level of difficulty for most of the items in the four valid pattern subtests. On the other hand, the analysis shows that all items in the invalid pattern subtests were very difficult. In general, the items in the P. W. [Physical World] content subtests were the least difficult and usually yield the lowest reliability coefficients. The symbolic subtests usually yield the largest reliability coefficients.[3]
>
> . . . . . .
>
> The means of the four valid patterns, law of detachment, contrapositive inference, hypothetical syllogism and disjunctive syllogism, are all above the random expected means. The means for the invalid patterns affirming the consequent and denying the antecedent are below the random accepted means. On the other hand, the means for the usual error responses to each invalid pattern are above the random expected means. [The metric on all patterns was number correctly answered.][4]

ANOVA for the four content types showed content to be significant at the .01 level and a content by grade interaction ($p \leq .01$). From these findings, Miller was able to offer some generalizations relevant to logical connectives:

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[1]Miller, "The Acceptance and Recognition of Six Logical Inference Patterns by Secondary Students," p. 57.

[2]Ibid., p. 60. [3]Ibid., p. 82. [4]Ibid., pp. 87-88.

> In general, the results of the analysis of the correct responses to invalid patterns indicate that for the vast majority of the students, the analysis was performed on a random error response. These students, with the exception of a few above-average tenth and twelfth grade students, accepted the invalid patterns as valid.[1]
>
> . . . . . .
>
> The pattern rank of means from highest to lowest was law of detachment, contrapositive inference, hypothetical syllogism and disjunctive syllogism.[2]

Paulus studied conditional reasoning of subjects in grades 5, 7, 9, and 11. By "conditional reasoning" he meant that at least one premise in each argument would be a conditional--there was no specification of which form of the conditional was used or whether there was, in fact, an attempt at uniformity of expression. In any case, the final test of 10 deducing and 10 assessing[3] items on six principles of conditional reasoning was administered in his final study to 165 subjects from two upper New York state school systems.[4] Although "maybe" and "nothing" responses created problems of interpretations[5] Paulus was able to conclude that the ability to reason deductively may not be a unitary trait as assumed by Piaget and others.

Other Reports on Connectives. After studying pictoral and verbal class reasoning in 445 suburban New Jersey students in grades 3 through 9 and 85 Douglas College sophomores in psychology, Neimark and Slotnick were able to write as follows:

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[1] Ibid., p. 130.

[2] Ibid., p. 136.

[3] Paulus, "A Study of Children's Abilities to Deduce and Judge Deductions," p. 10.

[4] Ibid., p. 57.

[5] Ibid., p. 81.

> [Class] inclusion and exclusion are understood by the majority of subjects at even the young[est] ages . . . , conjunction questions are answered by a majority of subjects at all ages . . . . The proportion of each age group correctly answering disjunction (union) items increases gradually with age but it is not correctly answered by the majority of the group except at the college age level. For disjunction, the wording of the item does appear to have an effect . . . . Unqualified statements "A or B," appear to be slightly easier [but not significantly easier] than qualified ones "A or B or both.[1]

There appeared to be no effort directed toward understanding the conditional, the biconditional, or the negajunction; neither was anything reported on negation prefixes.

At least one experimenter, Wells, has found disjunctive concept learning to be easier than conjunctive concept learning.[2] Equally- or more-impressive research has shown the opposite to be true--that disjunctive concepts are more difficult than conjunctive concepts. First among these reports was that of Bruner, et alli followed by Conant and Trabasso, King, Snow and Rabinovitch, Seggie, and King and Holt.[3] All have in common the properties of representing results of oral examinations having cards or blocks as primary stimulus items and of being based on relatively few cases.

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[1]Edith D. Neimark and Nan S. Slotnick, "Development of the Understanding of Logical Connectives," Journal of Educational Psychology 61 (December 1970): 453-454.

[2]Herbert Wells, "Effects of Transfer and Problem Structure in Disjunctive Concept Formation," Journal of Experimental Psychology 65 (January 1963): 63-69.

[3]Jerome S. Bruner, Jacueline J. Goodnow, and George A. Austin, A Study of Thinking (New York: John Wiley and Sons, Inc., 1956); Michael B. Conant and Tom Trabasso, "Conjunctive and Disjunctive Concept Formation Under Equal Information Conditions," Journal of Experimental Psychology 67 (March 1964): 250-255; William L. King, "Learning and Utilization of Conjunctive and Disjunctive Classification Rules: A Developmental Study;" Catherine E. Snow and M. Sam

General Criticism of Logical Connective Studies. Most studies on logical connectives uncovered for this review might be criticized because of their conspicuous lack of coordination of findings for one type of connective or rule with other types. This omission prevailed not only within groups that might have yielded data on the various connectives but also across groups. It is true, however, as can be noted above, that some efforts were made at coordinating two types of reasoning--conjunctive with disjunctive and class with conditional.

EFFECTS OF FORMAT

Logical form and structure in arguments--their message characteristics--have been viewed traditionally, but inaccurately, as having inherent power for transmitting "reason" directly to the mind of the receiver. Even incomplete arguments were thought to possess this power. In fact, Aristotle's enthymeme, although strictly incomplete as a syllogism since a premise is implied, has been credited by its form to possess elements of validity.[1]

Rabinovitch, "Conjunctive and Disjunctive Thinking in Children," Journal of Experimental Child Psychology 7 (February 1969): 1-9; J. L. Seggie, "Levels of Learning Involved in Conjunctive and Disjunctive Concepts," Australian Journal of Psychology 21 (December 1969): 325-33; and William L. King and Julia Rae Holt, "Conjunctive and Disjunctive Rule Learning as a Function of Age and Forced Verbaliation," Journal of Experimental Child Psychology 10 (August 1970): 100-111.

[1]Jesse G. Delia, "The Logic Fallacy, Cognitive Theory, and the Enthymeme: A Search for the Foundations of Reasoned Discourse," Quarterly Journal of Speech 56 (April 1970): 140-148.

In 1935, Woodworth and Sells noted that order of premises in a syllogistic argument seemed " . . . to have little effect on their atmosphere or on the acceptance of the conclusion."[1]

In the comparatively recent past, Paulus found, with correlation techniques, that his conditional reasoning subtests tended to group themselves into "valid moves" and "invalid moves" (four valid and two invalid).[2] This is about what one would expect since the six argumentative principles on which his conditional reasoning instrument was based represent four valid argument forms and two invalid forms.

In addition Paulus found that subjects in grades 5 through 11 more easily assessed arguments than deduced correct conclusions. For his conditional reasoning instruments, he stated, without amplification, that " . . . the assessing form is considerably easier for subjects than the deducing form of the tests."[3] There is no evidence whether this generalization extrapolates to other forms of deductive reasoning: biconditional-, conjunctive-, disjunctive-, and negajunctive-reasoning. Also, there is no evidence that the finding with conditional reasoning extends to adults. Nevertheless, Paulus stated that by about the 11th grade " . . . children tend to score about the same on measures of the two abilities [assessment and deduction]."[4]

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[1] Woodworth and Sells, "An Atmosphere Effect in Formal Syllogistic Reasoning," p. 458.

[2] Paulus, "A Study of Children's Abilities to Deduce and to Judge Deductions," pp. 57-75.

[3] Ibid., p. 92.

[4] Ibid., p. 126.

Roberge claimed to be concordant with investigators of adults' syllogistic reasoning abilities in finding that "reversal of premises did not alter the difficulty of the deductive reasoning items for the [228 public school] subjects tested in this investigation."[1]

Henle tested 46 graduate students of psychology, most with no training in formal logic, for their capacities to judge "logical adequacy" of arguments " . . . presented in the context of everyday problems."[2] She believed that there were six sources of error associated with syllogistic reasoning. These errors are related to--

1. form of the syllogism and its contents,
2. instructions to subjects,
3. failure of subjects to accept the logical task (decision to accept versus rationalization),
4. restatement of a premise or conclusion by the subject such that the intended meaning is changed (error of translation),
5. omission of a premise (as in an enthymematic argument), and
6. slipping in of additional premises.[3]

Stolurow hypothesized that " . . . formal structural features of [argumentative] tasks can serve as cues for the formation of learning

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[1]James J. Roberge, "The Effect of Reversal of Premises on Children's Deductive Reasoning Ability," The Journal of Psychology 75 (May 1970): 57.

[2]Henle, "On the Relation Between Logic and Thinking," p. 369.

[3]Ibid., pp. 366-378.

sets."[1] In this sense, different logical systems may provide different cues; for example, arguments based on symbolic content may cue an individual differently than forms used for arguments having propositional content.

Visual positional cues in relational phrases are features that seem to affect an individual's judgments of logical validity. Miller's review of research in 1969 provides an index to the then current state of the art. Summarizing "a large body of research on this problem . . . by German investigators," Miller noted that they provide "evidence for the importance of spatial and positional cues in syllogistic reasoning." For example, logically equivalent arguments containing the phrase "to the left of" are of significantly different difficulty than if "to the right of" is used, the spatial relationship "over" lends a less difficult quality to arguments than "under," and "stands in front of" provides less difficulty than "stands behind."[2] Miller emphasizes this point with respect to structure of arguments based on symbolic content. In his words, " . . . prior experience with positional cues [say in reading and writing habits] may influence a person's ability to judge the validity of an argument, particularly if the argument is presented in an abbreviated form which leaves the conclusion unstated."[3]

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[1]Lawrence M. Stolurow, "Psychological and Educational Factors in Transfer of Training," Quarterly Reports 8 and 9, an ERIC typescript having Accession Number ED011960, (Urbana, Illinois: Bureau of Educational Research, Illinois University, September 30, 1964), p. 222.

[2]Gerald R. Miller, "Some Factors Influencing Judgments of the Logical Validity of Arguments: A Research Review," Quarterly Journal of Speech 55 (October 1969): 277-278.

[3]Ibid., p. 278.

Miller concluded his review of factors influencing validity judgments with a strong recommendation for research on the contribution of argument format:

> Perhaps the most significant area for future research is to be found in the issue of argument format. Throughout this paper, a healthy skepticism toward unqualified generalization has been maintained, primarily because of the syllogistic, unabbreviated format of the arguments used in most prior research.[1]

EFFECTS OF TRANSLATION

It was reported in the last section that Henle believed one source of error in syllogistic reasoning to be a function of problems in restatement or translations of a premise or conclusion such that the intended meaning is inadvertently changed. Translation to inappropriate meanings may not be, moreover, an independent source of variation but may be interactive with other sources such as attitudes or atmosphere effect which will be discussed in later sections.

Although the possibility exists that translation has some basis as a variable in reasoning, it has not been widely accepted as a credible source of variation.

As one discusses translation as a variable, he is concerned with the formational properties of propositional sentences; whether those sentences function as premises or as conclusions. "Translation," thereby, should be distinguished from "transformation" which is a

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[1] Ibid., p. 286.

property of those inferential moves associated with deriving a conclusion from premises; that is, moves associated with the process of justifying a conclusion for an argument.

Printed arguments in the educational literature, in any case, rarely appear in the logicians pristine form for the educator to judge. The educator usually needs to assess disguised arguments as presented in professional documents. Whether the educator can translate those arguments into the logicians form is beyond the scope of this investigation. Unless he can accurately judge, and draw conclusions from, arguments already in logical form, however, he will probably be unable to accomplish these tasks reliably with disguised arguments and fragments of arguments embossed with the considerable verbiage characteristic of documents in educational literature and perhaps in need of some translation before judging.

Perhaps the clearest statement of the translation problem was proposed by Mills and Petrie. As a response to Anderson and Mortensen, they wrote as follows:

> Admittedly whenever one translates from one language to another (in this case from ordinary language to the formal languages of logic), the risk of distortion is always present. However, distortion is not inevitable. In fact, the ability to distinguish a distorted translation presupposes the possibility of an adequate translation, and hence, the possibility that formal logic can reflect the subtleties of ordinary language. . . . To be distorted is to fall short of some standard of adequacy, and the word "distorted" lacks all meaning if we cannot say in what the distortion consists. But that is just what we could not say if the possibility of an adequate translation were not presupposed. Thus on a priori grounds there is no logical impossibility in supposing formal logic capable of translating ordinary arguments without distortion, no matter how difficult this may be in practice. . . .
> . . . . . .

> . . . the warrant of an argument can equally well be considered as a missing premise in an enthymematic argument. . . .
> . . . . . .
> . . . by admitting the problems of translation [but conceding it can be done] one can retain the traditional account of logic.[1]

This question of translation was also raised by Rott, et alli. In their report they speculate that "perhaps the evaluation of arguments couched in ordinary language relies upon the analysis of that language and is, therefore, more related to verbal abilities than to general intellectual ability."[2]

EFFECTS OF ITEM DIFFICULTIES

It has already been observed that different types of reasoning problems seem to produce arguments of varying difficulties. William Anton Miller's work was cited earlier to indicate that difficulties vary from a low for "physical world" content to very high difficulties for items based on invalid reasoning patterns. The difficulties increased from "physical world" through content described as "violating physical world," "nonsense statements," and "symbolic" content.[3]

Elmer H. Miller also studied difficulty levels. His instrument, the "Fallacy Recognition Test" was used with 297 urban high school

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[1]Glen E. Mills and Hugh G. Petrie, "The Role of Logic in Rhetoric," Quarterly Journal of Speech 54 (October 1968): 264-267 passim.

[2]Robert K. Rott and others, "Student Abilities in the Evaluation of Verbal Argument: A Normative Study," p. 13.

[3]Miller, "The Acceptance and Recognition of Six Logical Inference Patterns by Secondary Students," p. 82.

students in a control group given no reasoning instruction and 32 high school students in an experimental group given reasoning instruction. He concluded that:

> There is a rank order of difficulty of fallacies as measured by the Fallacy Recognition Test. The rank order for the twenty-nine fallacies selected is as follows, most difficult fallacy first:
>
> 1. Arguing in a circle
> 2. False analogy
> 3. Denying the antecedent
> 4. Denying a disjunct
> 5. Affirming the consequent
> 6. Converse accident
> 7. Affirming an alternant
> 8. Undisturbed middle term[1]

EFFECTS OF ATMOSPHERE

An error associated with the so-called "atmosphere effect" is thought to be a phenomenon centered " . . . on acceptance of invalid conclusions that have the same structure [emphasis mine] as the argument's premises."[2] Also, atmosphere may be considered as a "non-logical verbal cue" extending through the premises to the conclusion for an argument. This atmosphere effect was first investigated by Woodworth and Sells in a classic study of variations in difficulty of specific combinations of syllogistic premises. Their hypothesized variations were due to--

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[1]Elmer H. Miller, "A Study of Difficulty Levels of Selected Types of Fallacies in Reasoning and their Relationships to the Factors of Sex, Grade Level, Mental Age, and Scholastic Standing," Journal of Educational Research 49 (October 1955): 123-129.

[2]Miller, "Some Factors Influencing Judgments of the Logical Validity of Arguments: A Research Review," p. 279.

1. "ambiguity of the language in which syllogisms are expressed,"

2. "caution or wariness on the part of the subject in an experiment," and

3. "atmosphere of the premises" creating "a sense of validity for the corresponding conclusion."[1]

In reworking data originally collected in experiments by Wilkins ("81 Columbia College undergraduates") and by Sells ("90 educated adults"), Woodworth and Sells claimed " . . . that nearly all the acceptances of invalid conclusions can possibly be explained by these three hypothetical factors."[2]

In a follow-up study using modified instruments with 65 adults having no previous training in logic and between 21 and 70 years of age, Sells concluded that "the results . . . demonstrate the operation of atmosphere effect in formal syllogistic reasoning."[3] His items were stated in a homogeneous abstract set of similar terms, each item conforming to a uniform format. An incidental finding related to free inference versus a closed procedure such as true-false or multiple option:

> The procedure of judging the <u>given</u> conclusion as true or false often tended to suggest an alternative to the subject which would not have occurred to him if the response had been a completion; i.e., a free inference. This fact was clear in the

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[1]Robert S. Woodworth and Saul B. Sells, "An Atmosphere Effect in Formal Syllogistic Reasoning," pp. 451-460.

[2]Ibid., p. 460.

[3]Saul B. Sells, "The Atmosphere Effect: An Experimental Study of Reasoning," p. 37.

> protocols of several observers in another experiment who made introspective reports of their experiences in solving the problems.[1]

One possible criticism of Sells' studies relates to his use of "true-false" rather than "valid-invalid" as responses for assessments of reasoning. True-false suggests the empirical status of a proposition manifested in perceptible phenomena while valid-invalid pertains to the logical consistency of a purported conclusion with its foundational premises. It is possible for a logically consistent conclusion to be factually false thereby providing a source of error for true-false options.

Other research has also been conducted with atmosphere related phenomena. Studying 109 introductory logic students at Colorado State University, Stolurow extended the Woodworth and Sells findings. Using concrete items, he found:

> People accept an invalid conclusion that makes a positive statement about something they consider good, or a negative statement about something they consider bad. This can be interpreted as an additional form of atmosphere effect.[2]

EFFECTS OF ABSTRACTNESS

On the basis of data from 97 graduate students Thorndike illustrated the theorem that "any disturbance whatsoever in the concrete particulars reasoned about will interfere somewhat with . . . reasoning,

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[1] Ibid., p. 36.

[2] Stolurow, "Psychological and Educational Factors in Transfer of Training," Quarterly Reports 8 and 9, Chap. 3: 34.

making it less correct or slower or both."[1] Interference, in the Thorndike sense, implies an increase in error probability and an increase in the time required to settle upon the response offered for a reasoning task.

A few years later Wilkins collected data from 81 undergraduates of Columbia College who were paid for taking her four-part test of various syllogistic forms and common fallacies. She exposed all subjects to syllogisms (1) "embodied in familiar material" but not concerning "actual facts within their experience;" (2) from "symbolic material, such as the letters, a and b, or x and y;" (3) of very "unfamiliar" terms or "nonsense words invented to sound like scientific words;" and (4) from "familiar words" expressing "facts within the experience of the subject" but "at variance with their validity [factual truth value] as deduced from the given premises."[2] Each syllogistic consideration examined was contained in each type of content permitting Wilkins to conclude that

> Ability to do formal syllogistic reasoning is much affected by a change in the material reasoned about. The easiest material is the familiar and concrete. The most difficult is the unfamiliar (long words). The symbolic material is almost as difficult as the unfamiliar. The suggestive material is more difficult than the familiar but not so difficult as the symbolic and the unfamiliar. . . . Some items vary widely in their relative difficulty as the material is changed. Most items increase in difficulty as the material is changed from familiar to symbolic, etc., but a few items representing very common fallacies are much less difficult in symbolic material than in

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[1]Edward L. Thorndike, "The Effect of Changed Data Upon Reasoning," p. 33.

[2]Minna Cheves Wilkins, "The Effect of Changed Material on Ability to do Formal Syllogistic Reasoning," p. 13.

> familiar. This is probably due to bad habits of every-day reasoning which are much in force in the familiar situation, but are not so influential when the material is symbolic or unfamiliar.[1]

Data collected by Long and Welch on 40 elementary school children 8½ to 11 years of age permit the extension of these generalizations with individualized testing in a block-grouping experiment to even younger subjects. They summarized their finding by stating that "as the level of abstraction is increased the ability of the child to generalize a known principle decreases."[2]

Woodworth and Sells felt that " . . . syllogisms with purely symbolic terms . . . have some of the advantages possessed by lists of nonsense syllables in memory experiments, in their freedom from extraneous associations and from factual truth or falsity."[3]

Using intercorrelation techniques, Sells then found that concrete items in measures of atmosphere have a higher reliability than abstract items.[4] He also found, by taking the ratio of mean abstract to mean concrete scores that " . . . abstract syllogisms are on the average 15 percent more difficult [(Abstract score/Concrete score) = .851 than concrete syllogisms."[5] While abstract and concrete syllogisms

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[1]Ibid., p. 77.

[2]Long and Welch, "Influence of Levels of Abstractners on Reasoning Ability," p. 50.

[3]Woodworth and Sells, "An Atmosphere Effect in Formal Syllogistic Reasoning," p. 451.

[4]Sells, "The Atmosphere Effect: An Experimental Study of Reasoning," p. 21.

[5]Ibid., p. 22.

evidently were differentiable in terms of difficulty, Sells was, nevertheless, disposed to suggest that:

> Logically, the material expression of a statement is irrelevant to its formal structure, but phenomenally it may be very importantly related to it. Verbal material has the advantage of being more familiar and meaningful and of presenting fallacies in a more glaring form. Symbolic material, on the other hand, is terse and concise, is free from extraneous associations and from factual truth or falsity.[1]

Any complete examination of abstractness as a variable in reasoning should acknowledge the theoretical contributions of Piaget, of Inhelder and Piaget, and of Flavell. Their writings guide one to believe that during the formal operations state of development formal thought proceeds from what is real to what is abstractly possible.[2] In functional support of this as the theoretical case, the literature seems to show that reasoning with the abstractly possible is a more difficult task than with the real or the familiar.

Karplus and Karplus examined 449 subjects ranging from fifth grade to science teachers with a Piagetian type task called "The Island Puzzle" obtaining results indicating that abstract reasoning intellect progresses gradually from grade 5 to grades 10 or 12 where a plateau "at a disappointingly low level" is reached. They found the order of development ascended across six Piagetian type categories which they considered adequately described and labeled as follows:

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[1] Ibid., p. 21.

[2] Jean Piaget, Judgment and Reasoning in the Child (New York: Harcourt, Brace, 1928); B. Inhelder and Jean Piaget, The Growth of Logical Thinking from Childhood to Adolescence (New York: Basic Books, 1958), and J. H. Flavell, The Developmental Psychology of Jean Piaget (New York: Van Nostrand, 1963).

(1) lowest, "N," cannot answer, (2) pre-logical, "I,", (3) transition to concrete models, "IIa,", (4) concrete models, "IIb,", (5) transition to abstract logic, "IIIa,", and (6) abstract logic, "IIIb," with I, II, and III representing Piaget's stages.[1]

Stone and Ausubel showed that prerequisite concrete background experience is necessary before Piagetian formal thought patterns are developed in a variety of subject matters. Of particular interest was their intentional avoidance of "use of analogy, example, illustration and personal reference . . . in order to insure that merely intuitive ideational understandings could not be generated"[2] in their 77 sophomores and 78 seventh graders in a suburban Chicago school system.

Henle and Michael, on finding differences in item difficulties as a function of content abstractness offered an interpretive suggestion: although "syllogisms stated in terms of popular issues are unwieldly and cumbersome," in symbolic syllogisms subjects and predicates are often interchanged by examinees untrained in logic, an error that is uncommon when the same propositions are verbally expressed.[3]

A contradiction to the above generalizations was provided by Paulus on the basis of his reasoning investigation of children in

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[1]Elizabeth F. Karplus and Robert Karplus, "Intellectual Development Beyond Elementary School," an ERIC typescript having Accession Number ED033854 (Berkeley: California University, Science Curriculum Improvement Study, 1969).

[2]Mary Ann Stone and David P. Ausubel, "Intersituational Generality of Formal Thought," p. 172.

[3]Mary Henle and Miriam Michael, "The Influence of Attitudes on Syllogistic Reasoning," The Journal of Social Psychology, 44 (August 1956): 117.

grades 5, 7, 9, and 11. He found them to have as much trouble judging arguments whose content is familiar as arguments with abstract content, observing also that the same children have less trouble deducing conclusions for arguments having more abstract components.[1]

In fact, Paulus found that children in grades 5, 7, 9, and 11 may be able to reason even more easily with "abstract" content than with "concrete neutral" content. Qualification was necessary because of a content by form (assessing and deducing) interaction.[2] Furthermore:

> These findings support the findings of the Cornell Critical Thinking Project . . . as far as the assessing form is concerned. The Cornell Project found that as far as principles of conditional reasoning were concerned, type of content did not affect subjects' scores on the assessing test. This investigation [Paulus'] does show, however, that on a deducing test, type of content does make a difference in subjects' scores.[3]

Paulus conceived of "content" after the fashion of Wilkins as being (1) concrete-familiar, (car, Ford), (2) symbolic, (x,y), (3) unfamiliar, (schlook, agloop), or (4) suggestive (familiar content having truth status known by the subject but used in such a way that conclusions drawn would be " . . . contrary to his factual knowledge"[4]). Concerning the suggestive content, Paulus offered the judgments that:

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[1] Dieter H. Paulus, "A Study of Children's Abilities to Deduce and to Judge Deductions."

[2] Paulus, "A Study of Children's Abilities to Deduce and Judge Deductions," p. 108.

[3] Ibid., p. 111.

[4] Ibid., pp. 34-35.

> One's opinion about the truth of a premise or conclusion [ideally] should not interfere with one's judgment about the validity of the argument containing these premises and/or conclusions.[1]
>
> A characteristic which is associated with the real-possible distinction [advanced by Piaget] and which is relevant to this [conditional reasoning] investigation, is that when a subject is able to deal with the possible, he is able to judge the validity of a logical argument by the form or logical structure of that argument alone, rather than on the basis of his beliefs about the conclusion of the argument.[2]

Abstractness in mode of presentation appears to be an important side-issue for the abstraction question. Using "pictorial," "ordinary verbal," and "abstract verbal" longitudinal (3 years) presentations of 35 problems to 800 boys between 7 and 12 years of age with measurements keyed to solution tactics, Rimoldi, Chlapecka, and Aghi concluded that the pictorial language is best at early ages for differentiation between logical structures, and that ordinary language and abstract verbal languages become better discriminators at about 9 or 10 years of age. Furthermore, they offered the thought that "a subject may not be able to solve a problem, not because he does not understand its structure but because he is not proficient in the use of the language in which it is presented."[3]

EFFECTS OF ARGUMENTATIVE CONTENT

Four cognitive interactions, of eight examples described by Osgood that invoke a basic dynamism in human judgment, belief, thought,

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[1] Ibid., p. 36.

[2] Ibid., p. 25.

[3] H. J. A. Rimoldi, T. W. Chlapecka, and Miri Aghi, "Problem Solving Processes Used by Elementary School Boys," FINAL REPORT, an ERIC typescript having Accession Number ED037805 (Chicago: Loyola University, Psychometric Laboratory, February 1970), p. 4.

or perception, seem to have a bearing on response attributes for arguments used to measure reasoning. The four relevant interactions are--

1. individual behavior with belief: "it is cognitively inconsistent to believe one way and behave another, . . . ";

2. perceptual affairs: the context of a perception affects the content;

3. the matter of naming: garnishment with a label may add distinction to or diminish the quality attached to a sensory perception (for example, noting that the house is in "the ghetto" or in "Sunnyvale Downs"); and

4. attitudinal affairs: " . . . we strive to maintain internal consistency among our attitudes and beliefs, often at the price of doctoring reality."[1]

In each of the above, psychological stress may result from cognitive inconsistencies such that cognitive modifications are produced. As stress magnitudes become larger, due to increased cognitive inconsistencies, the pressures toward congruity become more pronounced. Cognitive interaction dynamics operate " . . . such that modifications under stress always reduce cognitive inconsistency."[2] Moreover, " . . . those cognitive modifications (changes in assertions or in [cognitive] element valences) will occur which require the minimum restructuring of the entire cognitive map."[3]

Osgood provides a summary for inconsistencies with six rules of cognitive interaction discussed in his document on cognitive dynamics:

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[1]Charles E. Osgood, "Cognitive Dynamics in the Conduct of Human Affairs," Public Opinion Quarterly 24 (Summer 1960): 342-344.

[2]Ibid., p. 354.

[3]Ibid., p. 357.

> When in the course of human thinking, inconsistent cognitive elements are forced together by linguistic or behavioral assertions, stress is produced in proportion to the magnitude of the inconsistency, this stress producing cognitive modifications which--by changing the nature of the assertion, changing the connotative meanings of the elements, differentiating or integrating the denotations of the elements--serve to reestablish cognitive consistency. . . . The experimental literature . . . has become quite extensive.[1]

While authors reviewed in the remainder of this section on argumentative content do not purport to have followed-up the theoretical considerations of Osgood with empirical studies, their work seems to be very closely related to Osgood's interactive phenomenon.

Issues. Stolurow tested, with a 56 item syllogism test, 109 introductory logic students at Colorado State University requiring validity decisions of them in an effort to determine whether there might be a congruity by atmosphere interaction. His standard of congruity was associated with careful selection of nouns, their qualifiers, and assertions about the nouns selected. An incongruous proposition might be "all mothers are bad." According to Stolurow's experiments " . . . people are likely to accept an invalid conclusion if the conclusion makes a positive statement about something they consider good, or if it makes a negative statement about something they consider bad."[2] By writing congruous arguments an examiner may obtain respondee agreement even thought the arguments are invalid.

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[1] Ibid., p. 359.

[2] Stolurow, "Psychological and Educational Factors in Transfer of Training," Quarterly Reports 8 and 9, Chap. 3: 27.

Frase believed that "there is a monotonic increase in reasoning errors as semantic incompatibility increases." This belief was based on his finding that a curvilinear relationship exists between connotative compatibility of words used in syllogistic reasoning and reasoning errors with those syllogisms. The fewest errors were made on conclusions having low and moderate incompatibilities, the most errors on conclusions with high connotative incompatibilities. " . . . Compatible connotative meanings . . . seem to facilitate deductive reasoning rather than merely increasing the acceptability of a conclusion." In this sense, differential acceptability of the quantifiers "all," "some," and "none" seems to have an important association with belief in conclusions containing these quantifiers.[1]

An instrument consisting of 20 syllogisms having socially controversial content intended to emotionally excite respondees and of 20 syllogisms of neutral content matched with the first group of 20 in form and mood, was used by Lefford to measure 186 college students, male and female, freshmen through graduates. From these data Lefford was able to draw the generalization that "most subjects solve neutrally toned syllogisms more correctly than emotionally toned syllogisms."[2] He also concluded

> [that] the distributions of the partially scores [percentage of syllogisms marked valid and true plus the percentage marked

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[1]Lawrence T. Frase, "Effects of Semantic Incompatibility Upon Deductive Reasoning," Psychonomic Science 12 (25 August 1968): 64.

[2]Arthur Lefford, "The Influence of Emotional Subject Matter on Logical Reasoning," p. 137.

> invalid and untrue] tend to show: (a) that attitudes, beliefs, feelings, etc. influence reasoning in the direction of these convictions, and (b) that previous knowledge of the truth or falsity of the conclusions of the nE [non-emotional] syllogisms influences reasoning in the direction of that previous knowledge.[1]

By way of explanation of these results, Lefford offers the following rationalization for consideration:

> What presumably arouses this attitude may be the response to certain key words or phrases in the syllogism . . . . The emotional quality of the syllogism is probably taken from the affective connotations of the words or symbols which have been used in them. These words or symbols are emotional stereotypes of institutionalized complexes, and act as stimuli which excite positive or negative affective feelings.[2]

Still other investigators have examined the content-issue problem. According to Gardiner's review of prior research, there is a five level hierarchy for systematic variation of content within a given propositional component of an argument. His presentation of these content variables is so thorough, concise and communicative that a modification of it is reproduced as Table 2. In another case, Miller found a significant F-ratio ($p \leq .01$) in an ANOVA design having "content type" as a source of variation. Means for "physical world" were highest ranging through "violating physical world" to "nonsense" to "symbolic" content as lowest.[3] As a consequence of her study, Henle seemed to believe that people tend to evaluate content or issues in conclusions,

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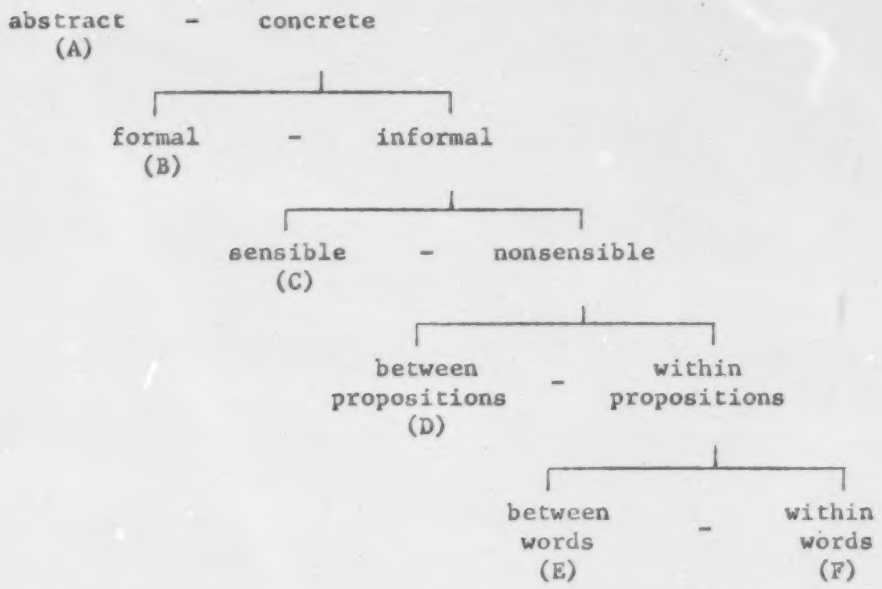
[1] Ibid., p. 139.

[2] Ibid., p. 147.

[3] William Anton Miller, "The Acceptance and Recognition of Six Logical Inference Patterns by Secondary Students," p. 105.

TABLE 2

SYSTEMATIC VARIATIONS OF CONTENT


abstract (A) - concrete
formal (B) - informal
sensible (C) - nonsensible
between propositions (D) - within propositions
between words (E) - within words (F)

(A) The constituent propositions are in the symbolic form of sentence letters such as "p" and "q."

(B) Propositions or events are substituted for "p" and "q."

(C) Propositions are factual statements consistent with previously held beliefs.

(D) At least one,proposition is contrary to fact thereby producing a logically valid conclusion without verifiable factual status (non-existent or false factual status).

(E) Propositions are nonsensical combinations of words even though they conform to English rules of grammar.

(F) Words are nonsensical combinations of English morphemes.

Source: William Lambert Gardiner, "An Investigation of the Meaning of Logical Operators in Propositional Reasoning," p. 12.

not the logical forms of arguments as a whole.[1] This confusion may confound logical criteria applied to arguments with factual criteria derivable from empirical analysis.

Evaluative-Substantive Terms. In the sub-topic "Effects of Logical Connectives" above, a case was made for utilization of context-invariant connectives in arguments used for researching deductive reasoning. Anderson and Mortensen, who were cited in that earlier sub-topic, also maintain that meanings of complex logical connectives may "explode" when they are used with evaluative-substantive terms like "Black Power" or "Communism." In addition, they claim that:

> . . . when meanings of a connective term multiply, the inferential leaps certified by that connective also multiply . . . . The connective itself may often become a persuasive device rather than a linguistic generalization that certifies an inferential leap.[2]

Henle and Michael constructed an instrument having 10 symbolic syllogisms matched with 10 syllogisms each loaded with a term such as "communism," "Russia," or a related matter. One hundred students (young adults) responded pointing " . . . to the conclusion that the results of an individual's reasoning need not be predetermined by the attitudes he holds [for loaded terms]."[3] Procedures out of which this generalization was synthesized, however, may be criticized on the

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[1]Henle, "On the Relation Between Logic and Thinking," pp. 366-378.

[2]Anderson and Mortensen, "Logic and Marketplace Argumentation," pp. 148-149.

[3]Henle and Michael, "The Influence of Attitudes on Syllogistic Reasoning," p. 123.

grounds that data for 46 subjects were unaccounted for and that the basis of the attitude judgment for each of the 54 subjects supplying data was a function of self-rating on a single question directly asking for "attitude toward Russia." Responses to the question were keyed as follows: "strongly against," -3; "neutral," 0; and "strongly favorable," +3. Only neutral and anti-Russian results were discussed.

INDIVIDUAL REACTION FACTORS

Responses elicited by arguments seem to be results of very complex processes involving harmonious integration of content such that the internal consistency of the respondee's cognitive system is maximized. When there is cognitive conflict, subjective rationality may represent the major restorative force acting to rebalance the system. This subjective rationality may include (1) objective inference upon a personally distorted image of reality, (2) a compromise between logical and illogical predispositions, and (3) application of mental processing rules which are in conflict with rules of logic. On the other hand, conclusions in harmony with basic predispositions may be accepted without great regard for the inferential moves producing them. Delia reported these various reactions to argumentative content in a partitioning similar to the following:

1. Logos indicating reasoned argument having reasons internally consistent with one's cognitive system
2. Pathos indicating argument based on one or more highly emotional premises

3. Ethos indicating argument depending on acceptance of the source of its authority[1]

Discussion in this portion of the literature review pertains to pathos. It examines some conditions under which people may be moved to respond more by their emotions than by the logic associated with the stimulus situations.

Shelley and Davis claim that the particular response option chosen for a stimulus " . . . is a function of the magnitude of the reaction potential of that response relative to the reaction potential of other responses." "The reaction potential for a given response is a function of the habit strength of that response multiplied by drive."[2] They claim, furthermore, that the reaction potential for logical problems stated in symbolic terms approximates zero. However:

> When the problem content is relevant to S's attitudes, S will tend to respond in terms of his attitude rather than in terms of the logical operations required by the problem to the degree that the reaction potential of the attitudinally evoked responses is greater than the logical response reaction potential.[3]

McGuire also spoke to this point claiming that persons tend to maintain consistency of attitudes in their judgments of arguments as

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[1]Jessie G. Delia, "The Logic Fallacy, Cognitive Theory and the Enthymeme: A Search for Foundations of Reasoned Discourse," pp. 140-148.

[2]Harry P. Shelley and Robert E. Davis, "Relationship of Attitude to Logical Problem Solving," Psychological Reports 3, No. 3 (1957): 526.

[3]Ibid., pp. 526-527.

well as to maintain logical consistency. If a person agrees with the content of an argument he will, with higher probability, judge that argument as valid.[1]

As early as 1944, it was acknowledged that attitude toward argumentative subject matter and conclusions drawn there-from are interconnected. Morgan and Morton introduced their report by noting that:

> It has . . . been widely recognized that a man will invent fictitious reasons or use unsound arguments in his zeal to support his prejudices--a process which psychologists have called rationalization. . . . A person is likely to accept a conclusion which expresses his convictions with little regard for the correctness or incorrectness of the inferences involved. Our evidence will indicate that the only circumstance under which we can be relatively sure that the inferences of a person will be logical is when they lead to a conclusion which he has already accepted.[2]

The conclusion reached by Morgan and Morton would seem to have a significant bearing on any investigation concerned with reasoning. Their concluding paragraph is as follows:

> While it is recognized that there is a great amount of variability shown by our figures, the general trend is clear. In a general way we may conclude that when syllogisms contains [sic] nothing to arouse a response based on personal convictions, the selection of a conclusion to two premises is determined about half by atmosphere effects and about a quarter each by logic and chance factors. When an issue is injected which relates to the personal opinions, wishes, fears, or convictions of an individual, the distortion shifts from the atmosphere effect of the syllogism

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[1] William J. McGuire, "Personality and Susceptibility to Social Influence," Handbook of Personality Theory and Research, ed. by Edward F. Borgotta and William W. Lambert (Chicago: Rand McNally, 1968), pp. 1130-1187.

[2] John J. B. Morgan and James T. Morton, "The Distortion of Syllogistic Reasoning Produced by Personal Convictions," The Journal of Social Psychology 20 (August 1944): 39.

> to the meaning involved in the terms of the syllogism. In addition, it seems that logic and chance factors play a slightly smaller part. In responses to such syllogisms, atmosphere effect contributes about a fourth of the deciding influence, logic and chance factors each contribute about a fifth of the deciding influence, and the personal convictions of the respondent contribute about 35 per cent control.[1]

Premises in the 15 emotional arguments in the syllogism test were based on vital issues discussed in newspapers and over radio--issues which were current at the time.

Osgood and Tannenbaum presented some theoretical considerations related to attitude that may be appropriately applied to the construction of reasoning tests. Three variables could be considered: (1) attitude toward the source providing statements, (2) attitude toward concepts represented in statements, and (3) the nature of any evaluative assertion relating source to concept(s). In their model, semantic space seems to always have an evaluative component as one of its dimensions. Appropriate scale labels for this factor might be (1) good-bad, (2) fair-unfair, (3) valuable-worthless, (4) pleasant-unpleasant, (5) approval-disapproval, and similar dichotomies. Two additional attributes of their theory should also be noted:

1. "Attitudes toward the various objects of judgment associated in messages must be measured in the same units if comparative statements about attitude . . . are to be made."

2. "In applying the semantic differential . . . , various objects of judgment, sources and concepts, are rated against a standard set of descriptive scales. To the extent that location on the evaluative dimension of the semantic differential is a reliable and valid index

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[1]Ibid., pp. 58-59

> of attitude (as determined by correlation with other criteria), it is then necessarily a generalized attitude scale."[1]

About a decade later Frase used sentences on three levels of congruity in 48 syllogistic conclusions. Sixty-four subjects judged the syllogisms for validity then rated the 48 conclusions " . . . on a series of probabilistic scales designed to measure belief." The mean incongruity rating of the universal and the particular conclusions correlated (PPMCC) -0.52 and -0.66 with their respective average belief ratings supporting " . . . Osgood and Tannenbaum's notion that the more incongruous an assertion is, the less its credibility."[2]

Lefford's study associating depth of desire for an argument's validity with the belief and judgment that it is valid has already been reported. An additional conclusion relevant to emotional responses was stated as follows:

> We may conclude then that the findings of our study are supported by the finding of other similar studies, and that the chief conclusion reached by all the studies is that accurate and unbiased reasoning is rare in an affective stimulus situation.[3]

Lefford offered some important warranting considerations for this conclusion that may be pertinent to developing additional instruments for measuring reasoning:

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[1]Charles E. Osgood and Percy H. Tannenbaum, "The Principle of Congruity in the Prediction of Attitude Change," The Psychological Review 62 (January 1955): 42.

[2]Lawrence T. Frase, "Belief, Incongruity, and Syllogistic Reasoning," Psychological Reports 18 (June 1966): 982.

[3]Lefford, "The Influence of Emotional Subject Matter on Logical Reasoning," p. 144.

1. "The attitude which the subject has toward the subject matter of his reasoning strongly tends to bring his reasoning into harmony with his feelings. These emotional attitudes are thus the arch-enemies of objective and clear thinking.

2. When emotional content is involved, the individual may not be able to bring himself to accept a conclusion and its implications.

3. "When the individual is faced with the necessity of judging the validity of the syllogism, and if the objective forces [of form and neutral content] are not stronger than the internal forces of his ego [excited by emotional content], then those basic emotional patterns of his personality will be the controlling factors in determining his choice."

4. "Theoretically, the mechanism of inference involved in the solution of the syllogisms is considered to depend on three factors: (a) the objective structure of the field in which the problem is being solved; (b) the knowledge and nature of the goal; and (c) internal factors (knowledge, attitudes, complexes) of the responding organism. The results are considered to be due to stereotyped reactions to the conceptual subject of the syllogisms."[1]

Thistlethwaite provided a summary of the effects of attitude upon reasoning known to him in 1950:

> Previous studies of the effect of attitude upon reasoning have either relied upon questionnaire material used in conjunction with syllogistic tests . . . or have failed to include control groups with which the experimental subjects could be compared . . . . The experiment to be reported includes a number of control groups, and unlike previous studies utilizes logical material other than syllogisms.[2]

On this basis Thistlethwaite tested whether attitudes "distorted" six different forms of conditional reasoning. His measures of "distortion" were derived " . . . from differential responses to

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[1]Ibid., pp. 146-150 passim.

[2]Thistlethwaite, "Attitude and Structure as Factors in the Distortion of Reasoning," p. 442.

emotional and neutral items . . . ."[1] He distinguished between his 36 emotional and 36 neutral test items as follows:

> The conclusions of the emotional items were designed so that ethnocentric subjects would judge them incorrectly thus getting a large number of errors on the 36 emotional items of the test. . . . Neutral arguments . . . whose contents refer to matters so prosaic as to seem trivial (or to unfamiliar and remote groups . . .) are assumed to be judged almost entirely upon the basis of structural properties, and very little if at all on the basis of attitudes and beliefs.[2]

Thistlethwaite's covariance analysis of errors on neutral items and of distortion scores associated with emotional content " . . . indicates that the hypothesis that attitudes and beliefs are a determinant of reasoning cannot be rejected . . . ."[3]

Concerning the influences of needs and attitudes on reasoning processes manifested in responses to devices for measuring their outcomes, Henle offers the following:

> It is a plausible hypothesis that these [motivational] influences do not distort the reasoning process, as has frequently been stated or implied--indeed that they do not act at all on the reasoning process--but rather that they affect the materials with which thinking works . . . . It may be that a strong attitude toward, or emotional involvement with, particular material is in part responsible for the difficulty which many unsophisticated subjects experience in distinguishing between drawing a conclusion that is logically valid and one that is believed to be correct. . . .
>
> . . . . . .
>
> An attitude can select from among the possibilities that the material presents, singling out, for example, one among several possible meanings. It may be that such a process is responsible for . . . changes in the meaning of premises . . . .[4]

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[1] Ibid., p. 443. [2] Ibid., p. 444. [3] Ibid., p. 458.

[4] Henle, "On the Relation Between Logic and Thinking," pp. 374-375.

Attitudes of 25 midwestern subjects of known occupational roles were studied by Kerlinger with an 80 statement Q-Sort technique. In summarizing his results he wrote:

> Evidently occupational rôles and rôle expectations are a potent independent variable influencing attitudes and attitude structure. Individuals having similar rôles have similar attitudes, and vice versa.[1]

Kerlinger replicated the study with adults from the eastern part of the United States reporting that:

> The most important finding of this study and the one that preceded it is that there are apparently two basic dimensions or factors underlying attitudes toward education: Pragmatic Progressivism and Traditionalism.[2]

An instrument measuring reasoning should not include issues that would arouse strong emotional responses from either attitude group.

Janis and Frick constructed a test of 16 concrete syllogisms to measure the association between attitudes and conclusions and errors in judging for 19 graduate students at Columbia University, none having had formal logic training. "The validity of the syllogisms was determined by the experimenters on the basis of logical rules."[3] "The conclusions of all the syllogisms were presented in random order and the subject was asked whether he disagreed or agreed

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[1] Fred N. Kerlinger, "The Attitude Structure of the Individual: A Q-Study of the Educational Attitudes of Professors and Laymen," p. 312.

[2] Fred N. Kerlinger, "Progressivism and Traditionalism: Basic Factors of Educational Attitudes," The Journal of Social Psychology 48 (August 1958): 129.

[3] Irving R. Janis and Frederick Frick, "The Relationship Between Attitudes Toward Conclusions and Errors in Judging Logical Validity of Syllogisms," Journal of Experimental Psychology 33 (July 1943): 75.

with each of them."[1] Agreement or disagreement for an item was assigned according to Janis and Frick's anticipation of "general agreement or general disagreement with a minimum of neutral attitude responses," the latter being determined presumably by omitting an item. The often-quoted results of this investigation might be paraphrased as follows:

1. When there is agreement with conclusions, more logical validity judgment errors are made by accepting invalid conclusions than rejecting valid conclusions.

2. When there is disagreement with conclusions, more logical validity judgment errors are made by rejecting valid conclusions than accepting invalid conclusions.

An additional comment of Janis and Frick should receive attention here:

> Since the experiment was restricted to syllogisms, further tests on other types of material are necessary in order to increase the degree of confirmation of the two general hypotheses. It might be expected that tests of items in which the arguments are not so skeletonized will provide additional confirmation, because psychological factors affecting errors in the judgment of logical soundness probably are even more effective when it is difficult to discover the premises.[2]

It should be noted that attitude errors may be thought of as being classifiable into two broad clusters:

1. Logically valid conclusions that a subject disagrees with and judges invalid

2. Logically invalid conclusions that a subject agrees with and judges valid

Kane's data from high school students, college seniors in teacher education, and logic students also support these contentions. His data supported the hypothesis that "people tend to accept invalid reasoning

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[1] Ibid., p. 75.

[2] Ibid., p. 77.

as valid when it leads to a conclusion with which they agree and they tend to reject valid reasoning as invalid when it leads to a conclusion with which they disagree."[1]

Thouless also investigated the relationship between judging arguments and agreement with conclusion contents using as argumentative data such issues as "socialism," "life after death," and "war." Each item was responded to in two ways by each subject--

1. "true" or "false" conclusion, and
2. "sound" or "unsound" argument.

The item was then marked as "right" or "wrong" depending on whether the assessment judgment in the second response was "valid" or "invalid" according to rules of logic. A complicated calculation of "index of content influence" was then made for each of 59 subjects from the Education Department at Cambridge who were studied. A significant procedural modification recommended by Thouless should be noted:

> One obvious modification that I should make in any future revision of the test is that of printing the conclusions on a separate sheet to be marked by the subjects and collected before the sheets containing the arguments are distributed.[2]

Feather went beyond his predecessors attempting to demonstrate that evaluation of arguments (that judging arguments by argumentative content) is negatively related to critical ability and positively

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[1]Robert Bignal Kane, "Some Effects of Beliefs About Conclusions of Arguments on the Ability to Judge the Validity of the Arguments" (Ph.D. dissertation, University of Illinois, February, 1960; Ann Arbor, Michigan: University Microfilms Number 60-3,936), p. 40.

[2]Robert H. Thouless, "Effect of Prejudice on Reasoning," British Journal of Psychology 50 (November 1959): 293.

related to an intolerance for inconsistency.[1] He considered critical ability to be " . . . ability to judge the soundness of the logic with which the conclusion of an argument (having neutral content with respect to religion) is drawn."[2] In contrast to Thouless who collected attitude data immediately after having subjects judge arguments--in fact, on the same answer sheets as argument assessment responses, Feather administered his "Religious Attitude" scale one week after the "Reasoning Test."

> This test consisted of the conclusions of the 12 proreligious and 12 antireligious syllogisms presented as an attitude scale in the same order in which they appeared in the Reasoning Test. Subjects were required to check the extent to which they agreed or disagreed with each statement using numbers +1, +2, +3 in the direction of increasing agreement, and -1, -2, -3 in the direction of increasing disagreement.[3]

Emotional involvement also seems to affect the reasoning abilities of children. Wolfe reported a finding that children in grades through six have " . . . most difficulty identifying untrue generalizations when the generalizations agreed with their beliefs."[4]

A new dimension was added by Koen who measured degree of physiological arousal in 14 paid female undergraduate volunteers with a "Grason Stadler Type Operant Conditioning Apparatus" using 12 syllogisms. Koen confirmed the tendency of subjects to judge arguments valid if their argumentative content is agreed with. More precisely:

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[1]N. T. Feather, "Acceptance and Rejection of Arguments in Relation to Attitude Strength, Critical Ability, and Intolerance of Inconsistency," Journal of Abnormal and Social Psychology 69, No. 2 (1964): 127-136.

[2]Ibid., p. 128.

[3]Ibid., p. 130.

[4]Willavene Wolf, "Logic and Critical Reading," p. 425.

> . . . publicly expressed opinion about the content of an argument seems related to the accuracy of logical judgment, in the sense that the desire on the part of Ss to make judgments consonant with their personal opinions appears greater than that to follow rigorously the logic of the argument. Perhaps the results are not due to an inability to separate opinion from judgment, but to setting a greater value on consistency relative to the former. This may amount to a value decision in which less internal dissonance is anticipated by making "logical" judgments consistent with one's own previous public statements than by asserting one kind of opinion, then making judgments "contrary" to it. To take issue with the factual basis of a group of statements, then accept the argument they may make, in some sense, reflect on the perspicacity and appropriateness of the opinions.[1]

Another finding of Koen has value in the design of additional reasoning research, particularly in those aspects of design associated with argumentative content and response quality:

> Previous research has investigated bias associated with personal opinions related only to the conclusions of syllogisms. An analysis of the results in terms of each of the premises independently as well as the conclusion shows them to be completely consistent.[2]

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[1]Frank Koen, "Arousal and Logical Inference," an ERIC typescript having Accession Number ED016259, (Ann Arbor: University of Michigan, Center for Research on Language and Language Behavior, September, 1967), p. 7.

[2]Ibid., p. 6.

III. SOME IMPLICATIONS OF THE REVIEW

Premises that are acceptable for constructing arguments included in a reasoning test seem to be those that (1) are properly qualified, (2) do not violate generally accepted facts, and (3) contain neutral components. While ability to reason with premises that are believed false may represent a legitimate area for specialized inquiry associated with variations in factual content as an experimental variable, the use of false premises in this case would introduce a confounding factor. The evaluation of reasoning based on premises believed factual and true by respondees seems to be the most productive avenue of inquiry for the researcher in education or its sub-disciplines. This is particularly optimum since an argument itself is incapable of establishing the truth conditions of its premises. All that one can do by analysis of a full-blown argument is verify inferential thought processes resulting from transitions between premises and conclusion providing the premises are true.

The fact that logic can test results of concluding only and not the truth status of either premise(s) or conclusion is made the basis of a specific method of proof known as Reductio ad Absurdum. This method utilizes correct reasoning to produce a conclusion known to be empirically incorrect thereby providing certainty that at least one of the premises is factually false.

It is this writer's opinion that true-false responses should not be used in a reasoning instrument since valid-invalid is more appropriate and since individual subjects may have a response set for either true or false which bias their scores, particularly if there were to be an unequal number of true and false items.

Faced with an argument and the necessity to judge its validity, a respondee may be scored according to the actual validity of the argument and the accuracy of the response chosen. If the respondee judges a valid argument to be valid or an invalid argument to be invalid, he responds correctly. It is also possible to score, as correct or incorrect, a respondee's selection of a response from a set of options one of which best completes an argument fragment. Whether judging or "assessing" scores and selection or "concluding" scores are independent has not been unequivocably determined.

Previous instruction in logic, mathematics, and science may or may not influence reasoning. The effect of intelligence remains to be settled; sex and age appear to be unimportant variables although their range of effects are unclear. Order of premises does not seem to be a factor particularly if results of syllogistic reasoning generalize to the other types.

Habits of reasoning governed by one's generalized conception of "good" reasoning may overlap with his attitudinal orientation to content of arguments used to measure his reasoning. While reasoning habits may be a difficult variable on which to collect empirical data, attitudinal reactions to arguments may be realistically measured and suffice for both variables.

The researcher should standardize the various possible logical connectives that could be applied to the development of a measuring device. While such standardization may not employ truly context-invariant logical operators, the translation problem for all arguments based on a particular propositional form is minimized. Furthermore, the researcher should employ an instrument that is sufficiently varied in its contents to provide for measuring differential understandings associated with variations in the logical connective operators known as the conditional, biconditional, disjunction, conjunction, and negajunction. This is particularly true since basic differences seem to exist among arguments containing different logical connectives in their premises. Moreover, individuals will probably show significant differences among types of reasoning according to their educational predilections--it is expected that one person will favor conjunctive type reasoning, another disjunctive, and so forth according to his educational predispositions as reflected in his departmental classification. Although performative differences will probably pervade all educational identifications individuals within specific professional areas may also perform differentially with each species of argument, this differentiation being a function of sex, of previous instruction in mathematics, the sciences, and logic, and of emotional reaction to argumentative content.

The use of sentences in a logic test rather than symbols may confound results. The semantic influences of concrete propositions in sentence form may interfere with responding. However, since educational literature is propositional in nature and since educators

reading this literature need to be able to evaluate propositional arguments, it is felt that the purposes of an investigation in the field of education will be best served with selection of propositional arguments for inclusion in the basic, reasoning instrument.

Because of possibilities for confounding of results as a consequence of variations in argumentative formats within reasoning instruments it would seem desirable to select a format which can be adhered to across all items of a reasoning instrument. This homogeniety of items in the sense that they conform to a uniform format more or less obviates the possibility of open questioning particularly if specific logical consistency variables are studied as reflected in the language of premises and focal conclusions. Moreover, each item should be based on familiar and concrete statements especially if the researcher's goal is to discover whether respondees might be able to reason with arguments from their respective fields barring translation problems associated with isolating and restating premises and conclusions such that consistency considerations are opened for examination on more than an intuitive basis. The researcher should exercise caution in the construction of each familiar or concrete content item in an effort to insure that intuitive ideational understandings yield to the logical by avoiding analogies, examples, illustrations, and personal-references, -wishes, -fears, and -convictions as well as non-analytic content such as commands, reproaches, questions, laments, exhortations, and plaudits.

Another consideration relates to maintenance of a sense of respondee neutrality for the arguments that he reacts to. This affects construction of arguments in that the researcher should use

neutral nouns and adjectives, and avoid combinations likely to create stress through cognitive inconsistencies (dissonance). The quantifiers "all," "some," and "none" should not appear unless it is the researcher's desire to create controversial arguments. While adhering to these controls, it is still incumbent upon the researcher that he creates arguments whose factual criteria are not confounded with the logical criteria of interest, a feat requiring even more caution in avoidance of explosive, evaluative-substantive terms such as "communism," "Catholic," "conservative," "Watergate," and so forth. His argumentative content should, in short, relate to prosaic or trivial matters as might be encountered in groups that are unfamiliar and remote to the respondees.

Validity of reasoning as manifested in formal arguments with a given set of options may be established, as Janis and Frick did, on the basis of logical rules.

The majority of previous investigations were encumbered with one or more of the following evasive or ambiguous properties:

1. Only one or two types of reasoning, of five or six types, were studied. Most focused on syllogistic reasoning.
2. Only "valid" or only "invalid" argumentative moves were considered, frequently by having subjects respond with "true" or "false."
3. Only symbolic, ethnocentric, or nationalistic content contributed to the substantive material of the arguments--no investigation reported designs based on content from the field of education.
4. Only one logic skill, either assessing or deducing, was measured.
5. Only children's performances were used in attempts to generalize effects of age.

6. Visual positional (or spatial) cue considerations were omitted.

7. Only arguments in standard format of logicians' logic would be presented within instruments for measuring reasoning.

8. Only with syllogistic arguments was the "atmosphere effect," or comparable phenomena, studied.

Any new investigation should represent an attempt to overcome some of these problems in the study of its specified target population. Its instrument, moreover, should be constructed in a manner conforming to as many as possible of the implications from this review.

This instrument, for each type of reasoning, should include provisions for assessing decisions involving both valid and invalid principles of reasoning with content from the focal-area or -discipline of concern in the investigation. It should also measure decisions for each structural type of logical argument sampled from the field of logic as presented in major textbooks, and it should have subtests of size yielding acceptable levels of internal consistency reliabilities. Moreover, the instrument should be designed to answer specific questions with characteristic arguments pertinent to informational needs of the discipline initiating inquiry.

Affects of arguments on respondees, apart from their logical properties, should also be measured. Emotional affects might be of particular interest. These might be indexed by having each respondee react to each "conclusion" (including detractors) on some scaled continuum, say an approval-disapproval continuum having three to five intermediate scale values, one of which is designed to communicate ambivalency.

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